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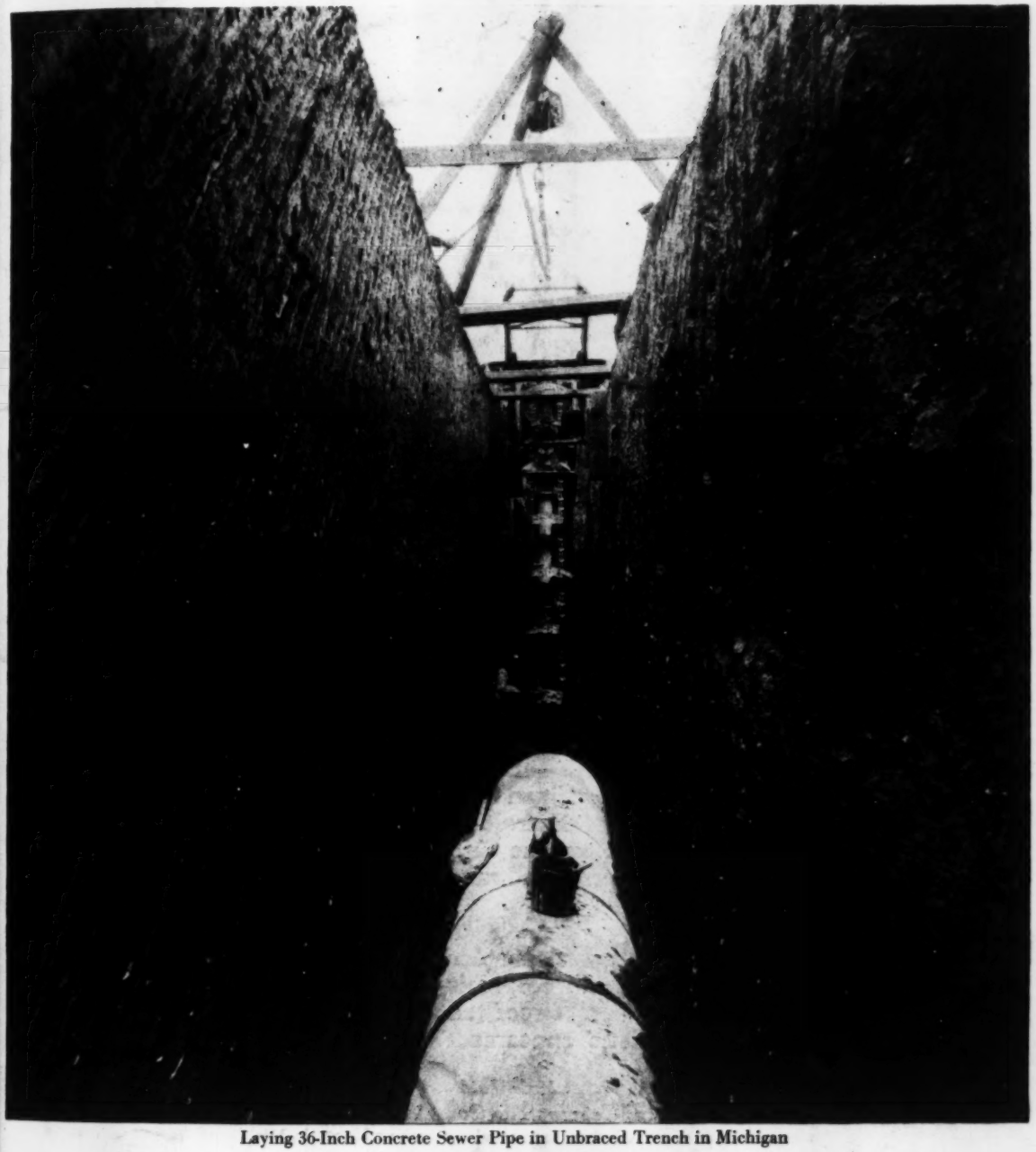

Laying 36-Inch Concrete Sewer Pipe in Unbraced Trench in Michigan

Economics of Activated Sludge Process — Concrete structures for D. L. & W. new grade crossings — Erecting office building over complicated track layout — Convention report of American Railway Engineering Association — Half dozen pages of Job and Office articles

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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To Smooth Out the Curves

IN THE depressed period just after the war, when unemployment steadily increased and construction languished, repeated demands were made upon the government to "take up the slack," that is to start much-needed construction which would call for the use of men and materials and tide over the depression. Unfortunately, the government agencies were not then organized for such quickly responsive action and the curve of business had to take its course unaided. Since then, however, a more scientific view of business depressions has arisen at Washington and the Department of Commerce, under Mr. Hoover, is watching construction closely enough to attempt, at least, to smooth out its curve by the expedient of restriction or expansion of the government's own construction. Hence the Hoover letter to the President, noted in the news pages. Construction is going ahead now fully up to the capacity of labor and material to fulfill. The curve of volume is on the rise and the curve of prices is going along with it. The saturation point will soon be reached and beyond that prices may go anywhere, with the invariably succeeding dead slump in volume and a consequent long period of depression and then a rise to the original level. It is only the part of wisdom to keep out of this saturating market those government demands which can just as well wait for a time when men and material are seeking use rather than the contrary. If the President will now follow the Hoover advice with absolute orders we may see to what extent the new theories of influencing economic trends are applicable.

The Sentimental Engineer

COLD-BLOODED, calculating, utilitarian—so runs the popular characterization of the engineer; a man of figures and machines, necessary for the workaday things of the world but devoid of sentiment and a sense of beauty. Once in a while, though, he surprises the world, and his latent and too frequently suppressed emotions shine through the overlay of practicality. Just now the city of New York is witnessing such a revelation. Old High Bridge, the finest example of masonry viaduct in America, is threatened with removal. Two years ago the engineers of the city thought they had won their campaign to have the arches which constrict the Harlem River replaced with a single span in keeping with the fine symmetry of the remaining spans and clear of any possible boat traffic in the river, but last week the city fathers, driven by obscure demands, moved to rescind their prior action and ordered the entire structure removed. The combined engineering forces in the city immediately took arms and at a public hearing forced reconsideration of such unnecessary ruthlessness. A monument to a pioneer American engineer, a model of a fast disappearing art in structures, an inspiration to all who glimpse its graceful arches from passing train or wooded path, High Bridge is more than a mere mass of stone and mortar to be torn down and thrown away after less than a century of use. The iconoclasts who urge its destruction have at least done the engineering profession one service. They have shown the people of New York that to the engineer the things of the spirit are of some value in the progress of the world.

An Experiment in State Ownership

NEW JERSEY has followed in the wake of several of her sister states to the west and has ordered the construction of a state cement plant. It remains to be seen whether she will follow the lead still further and neglect to build such a plant. Resentment against the high price and slow deliveries of cement is not confined to state highway departments, but it remains to be proved that these evils are the result of private ownership. The cement companies have put up a pretty fair argument in defense of prices, and one that can be answered only by the construction and operation of a state-owned plant. As to deliveries, that is something beyond the control of the manufacturer. Only actual operation can determine whether a state-owned plant means cheaper cement to the state. There is not the danger of political control that lies in the state ownership of utilities, but there are still the possibilities of false accounting, the loss of taxes and the necessity of production over and above the needs of the state. If the state is to sell cement to its citizens, why not underwear or coughdrops? However, if New Jersey wants to try the experiment there are several other states that will be glad to have her try. It may prove pretty costly to the Jerseyites.

Activated-Sludge Progress and Problems

AMONG the newer methods of sewage treatment none has been studied as closely and by as many technically trained men as the activated-sludge process. This is due to the promise of the process as a whole and to the hope that at last a means has been found for recovering the fertilizing value in sewage. That the process may go beyond the mere recovery just mentioned and add to the nitrogen in the sewage is the belief expressed and elucidated by C. Lee Peck in his article in this journal last week on "The Fixation of Atmospheric Nitrogen by the Activated-Sludge Process." In our present issue Mr. Peck presents other possibilities and opinions under the heading, "Economies of the Activated-Sludge Process." Mr. Peck's conclusion in favor of paddle or other mechanical means of inducing activation rather than diffused compressed air is all the more significant because his conclusion was reached before George W. Fuller made his recent visit to England and recorded the fact that British practice points towards mechanical agitation (*Engineering News-*

Record, Feb. 15). The fact remains, however, that some of the British engineers still hold to air diffusion while mechanical agitation has gained no foothold in the United States and Canada, although tried here and there. Doubtless we shall be quick enough to change to paddles or wheels whenever their economy over diffused air has been established as of general application. Among Mr. Peck's other notable conclusions are: That it is desirable to settle, skim and aerate the sewage before it is mixed with activated sludge and to acidulate the surplus sludge as a part of the sludge dewatering process; and that possibly power consumption for activation may be reduced by the use of catalysts. Further observations and experiments will be needed before final conclusions on all these points can be reached. Meanwhile Mr. Peck has rendered a valuable service by summarizing his several years of painstaking study of this interesting subject.

Sounder Municipal Finance

THE displacement of long-term by short-term serial bonds is one of the encouraging signs in the municipal field. Not so many years ago, municipal bonds with a redemption date long after the possible life of the improvement were common. If these bonds had sinking-fund provisions they weighed lightly on the municipal authorities. Gradually city charters or general state legislation (the latter notably in New Jersey a few years ago) restricted the life of city bonds to that of the corresponding municipal improvement and established less easily evaded requirements for the redemption of the bonds when due instead of permitting the perpetuation and piling up of municipal indebtedness by refunding. Alternative to sinking funds were serial bonds. These restrictions, combined with a growing public sense of the evils of the old methods and an increasing appreciation of the merits of at least an approach to the pay-as-you-go plan, have not only made serial bonds common but have also shortened the length of the series. As a current illustration which presumably is fairly typical: Of 19 separate bond sales reported by the New York *Times* for the week ended March 2, no less than 16 were serial, while of the three not serial, one was for but three years, one for 15 and one for 20 years. Of the 16 serial issues, 7 were to be fully paid within 25 years and 11 within 31 years while 5 were to be paid within from 22 to 10 years. Of the entire 19 sales, 6 were of bonds to be entirely paid within 25 years. The longest life periods were a 2-45-year serial, giving an average life of less than 25 years and a 30-40 year serial issue.

Interstate Co-operation

ONE or two men sitting in the Arizona Legislature at Phœnix have on their consciences the postponement of the interstate compact which would have set in motion the development of the Colorado River and the protection of its lower areas against floods. By a tie vote that legislature refused to ratify the treaty which had been accepted by five states and the ratification of which by the remaining state and by Congress awaited only favorable action by Arizona. It is impossible, however, that local politics, tempered with a trace of justifiable self protection, should long hold up this novel solution of a troublous problem. Interstate co-operation in matters of public works is not unknown but it is rare. The growing interdependence of the states in the utilization of their natural resources makes it more and more imperative that they join together or else submit to a nationalization which each state resents. The Colorado pact is the most important of such agreements because it involves such tremendous sums and such serious consequences of neglect, but it is not unique. Transportation, water supply, sewage disposal and power utilized in one state must reach over into a neighboring state to make that utilization complete and secure. Only by interstates agreement can full development be had. And such agreements will tend to become more involved and implicative. New York, for instance, seeking the co-operation of Pennsylvania in the distribution of the waters of the interstate Delaware—waters necessary for the future water supply of the metropolis—may lose some of her enthusiasm for sole control of power from her international border waters now that Pennsylvania has protested against that selfish view of water-power development. Governor Pinchot has not gone so far as to threaten but he has at least indicated wherein lies an enlightened self interest. Similar instances are bound to multiply. With the widening demands of industry and of the cities no state will be able to live to itself alone, nor will federal domination satisfy. Interstate co-operation is the sensible solution.

A Suggestion for the A. R. E. A.

DURING six sessions at last week's convention of the American Railway Engineering Association there were presented reports from twenty-four committees, most of them dealing with from three to a dozen subjects. All this matter had been printed in advance but the discussion was practically nil. Even in the absence of controversial subjects it seems strange that so much material should be accepted or adopted with practically not a word of real discussion in a well-attended meeting. Much of this material was simply "submitted as information" and thus perhaps failed to arouse much interest. It is true also that all of the material had been prepared and threshed out by committees, so that it was ready for formal action by the convention. Granting freely that all this material was good and useful, it seems impossible that all of it was to such an extent the "last word" as to offer no room for difference of opinion or even for expressions of confirmatory opinion or experience. Is it not a fair suggestion, that the sheer amount of material, especially in the absence of any one strong point, may have had a soporific effect, inducing a desire to let matters pass formally in order that the program might be carried through? In planning the program of work for 1923, the association's officers may well consider the possible advantages of some limitation of committee work, to see whether a smaller output of material during 1923 may result in greater activity and interest on the floor at the 1924 meeting, since it is discussion which adds life and value to the proceedings and the convention reports. For many years the American Railway Engineering Association has enjoyed an enviable position as a hard-working society. It cannot afford to lapse entirely into a committee-appointing body or to accept credit, as a body, for the work of separate groups of a few members each.

Primary Education and the Engineer

SOME weeks ago the Carnegie Foundation for the Advancement of Teaching startled the educational world with a well-considered, though none the less violent, attack on the sub-college educational system of the United States. It is the opinion of this authoritative body, made up of some of the leading educators in the country, that the public school system, partly because of its alarmingly rising costs and partly because of the inefficiency of its resulting product, is endangered and that unless we soon begin some reforms free education will cease to exist and the general average of intelligence and industry will decrease. These are serious charges disturbing indeed to a people who has been priding itself on the universality and efficiency of its instruction of youth. They are charges, moreover, which have more than passing interest to engineering educators.

It is the contention of the Foundation that a very large part of the rise in cost of education is "due to the change in the primary conception as to what the school is for and to the fact that that it is no longer conceived as primarily an intellectual agency, but rather as an agency through which the child shall learn something of every form of knowledge in existence, and in which he is not only to absorb such a knowledge but is to acquire the preparation for a trade or profession." In other words, the frittering away of time and effort on the sideshows of art and science and philosophy goes hand in hand with the forcing of the many through the paths that lead to the college which only the few ever reach, while meanwhile an amateurish manual training is offered in substitute for the serious trade school instruction necessary for those whose pursuits will be along manual lines.

Unfortunately, the Foundation only states the dilemma; it offers no solution. There are hints, promptly resented in the public press, of a classification of children into prospective intellectual and manual workers, but this is so manifestly impossible in our present social system and so contrary to the American ideal that it can hardly be taken seriously. The saving suggestion is for a return to fundamentals, for an elimination of the fancywork in the primary schools and a concentration on higher elements in the high schools, so that the finished product has a broad basis for future performance in any line, rather than a smattering of the outlines of every line.

These, the pity is, are mere words, the like of which have been heard for some time in discussions of engineering education. They intentionally avoid an attempt to predict or discover the unknown propensities or possibilities of youth, itself careless of its future. We do not know what man the child is father of; we do not know what specialty the embryo engineer will embrace. To that extent the insistence on fundamentals is sound. The difficulty arises, in primary school and technical school alike, when we attempt to define the fundamentals. Engineering educators are gradually feeling their way toward such a definition with increasing success. And that success will be expedited if the primary schools begin to solve their problem.

The ridiculous list of misspelled words cited in these columns last week by a western professor is a case in point. We are firmly of the opinion, and we say it in all seriousness, that a freshman in an engineering school who writes "dubble" should be summarily dismissed. There are words in the English language which it is permitted even the best educated man to misspell. Double is not one of them. To spell it "dubble" indicates a lack of common observation which is primary evidence of an untrained mind. A boy who at eighteen is capable of such inattentiveness simply has not the mentality required of an engineer or at least that mentality has not been developed to a point where he is capable of absorbing an engineering training. Who can doubt that the difficulties of engineering education are increased many fold by the defects of primary school instruction which thrusts such material on the engineering school?

Engineers, then, should be interested in the problems of elementary education, not only as citizens and fathers but as engineers, because the coming generation of their profession is involved. They should cease, both as citizens and as engineers, to leave these complicated questions to the appointed and elected boards of education and teachers. They can share the hope voiced in the concluding words of the Federation's report "that educated men outside the profession of teacher shall interest themselves in the general policy of education and in the fundamental conception under which the schools are to be operated."

Advanced Thought on Road Maintenance

LOCAL pride and observation is a controlling factor in road maintenance, according to J. T. Donaghey's recent paper at the roadbuilders convention. The technical advantages of direct state maintenance, he contends, are wiped out by the greater inspiration to improve the upkeep of the highways that maintenance through the counties give the people. They must be sold through the bumps or lack of bumps on the roads which they themselves travel.

The case for county maintenance is proved by mileage figures of maintenance extension. These figures deserve attention. Whether or not it is agreed that the reason given for them is correct the fact remains that in Wisconsin in some way the voluntary extension of state standards of road maintenance to a large mileage beyond the state system has been secured. This is accomplishment of an unusual kind.

Wisconsin experience proves, also, that road maintenance and tourist income are directly related. Roads are well kept to help sell the state as a vacation ground. The gross sales to tourists in five years are estimated at $300,000,000 and the profits perhaps $60,000,000. Both amounts are largely accounted for by the policy of keeping a great mileage of road perfectly surfaced, plainly marked and well mapped. While the tourist travel is always only incidental to the main use of the road for local transport, this through travel is definitely in mind in planning maintenance, as a means of earning the cost of keeping the roads in repair. This is an important thought and too few states are giving it consideration. Any state which has the natural attractions of woods, mountains and streams which invite tourists can by well-planned maintenance of its roads cultivate travel that will return all the cost.

There is no greater duty of highway departments than to sell road improvement to the people. Both of the practices described are powerful selling agencies. They have sold the policy of large and continuous road expenditures more completely than it has been sold in any but a few states other than Wisconsin.

Economics of the Activated-Sludge Process

Sedimentation, Skimming and Aëration Before Activation, with Acidulation of Surplus Sludge Proposed and Use of Catalysts to Reduce Power Consumption

By C. Lee Peck
Consulting Engineer, New York City

I. Where power costs do not exceed 2c. per kw.-hr. and the amount of sewage treated exceeds 1 m.g.d. the net cost of treatment should range between $20 and $30 per million gallons. This includes sludge disposal; also interest and amortization at 10 per cent per annum.

II. Plant design should include: (1) Preliminary treatment by sedimentation and skimming. (2) Shallow aëration, rapid removal of surface film, mixing it with the body of the liquor. (3) If bubble aëration is used, introducing the bubbles in as fine a state of division as practicable and prolonging contact with the liquor. (4) Maintaining dissolved oxygen at about 25 per cent of saturation. (5) Agitation by mechanism. (6) Acidulation of surplus sludge.

III. Suggested innovations: (1) Aërating the skimmed and settled sewage before mixing with activated sludge. (2) Use of catalysts to decrease power consumption.

This discussion is divided into (I) Theory of Aëration. (II) Aëration Practice. (III) Sludge Dewatering and Marketing. The purpose is cost analysis. Details of the process are necessarily omitted.

I. Theory of Aëration

IN THE economics of activated sludge, aëration is of first importance. The wastefulness of present methods is evidenced by the difference between theoretical and actual air requirements. The oxygen demand of a gallon of sewage might be satisfied with 0.05 cu.ft. of air and the actual requirements be 1.5 cu.ft. Intelligent effort to increase aëration efficiency must be based upon an understanding of the air needs of the sewage and the factors which influence the efficiency of the air applied.

In the activated-sludge process an accumulation of aërobic sludge is relied upon to clarify and otherwise remove objectionable constituents from the sewage. For the purpose of the present paper it is not necessary to speculate upon how this is done. It occurs in the presence of a healthy sludge. The problem is one of maintaining a congenial environment for the sludge. Aërobic organisms thrive where the sewage contains 2 p.p.m. of dissolved oxygen, or of oxygen held in lightly bound chemical compounds which may be reduced by the organisms. Raw sewage is not suitable for the propagation of aërobic organisms. It should be made suitable by preliminary treatment before adding the sludge.

Classification of Oxygen-Consuming Agents—The oxygen consuming constituents of sewage fall within the three following classes: (1) Substances capable of direct and practically instantaneous oxidation. (2) Dissolved or colloidal substances which oxidize slowly. (3) Suspended organic solids.

The sludge itself consumes oxygen at a fairly uniform rate. When raw sewage is aërated its oxygen demand is satisfied at an extremely rapid rate for the first thirty to sixty minutes. This is not affected by the presence of activated sludge. During this first period the sewage loses the greater part of the gases which are toxic to aërobes, CO_2, CO, SO_2, H_2S, etc. This period might be defined as the period of *direct oxidation*. It terminates rather abruptly. Classes (2) and (3) remain to be disposed of. Micro-organisms can economically oxidize by digestion practically all of Class (2) and the extremely finely divided portion of Class (3). The remainder of Class (3) can be more economically disposed of by preliminary sedimentation. Theoretically, sewage should first be settled, then aërated until the directly oxidizable substances are satisfied and treatment finished by aëration in the presence of activated sludge. Until recently this was impracticable. The disposal of the sludge from preliminary sedimentation by known methods was too expensive. The Maclachlan process seems to have solved the problem of raw sludge disposal. Maclachlan's experiments at Indianapolis, Brooklyn and Plainfield, N. J., have demonstrated that such sludge can be rendered inoffensive and easily drainable. The sludge is acidulated by injecting hot sulfur dioxid gas. When a hydrogen-ion concentration of pH 3.8 is approached the sludge turns straw color, the colloids coagulate. In this condition it dewaters readily. Dewatering follows immediately after gassing and is accomplished by collecting a sheet of the solids on an inward-flow drum screen and squeezing the water from the sheet with a felt-covered idler. The idler picks up the solids, which are scraped off by a doctor. In this condition they contain about 80 per cent moisture and may be stacked or dried in the open without nuisance or attracting insects. Raw sewage sludge which has been treated and dried, or dewatered to a proper condition for local transport, contains from 4 to 5 per cent ammonia (dry basis) and should be salable locally as a manure.

During the period of biologic digestion air must be supplied in quantity sufficient to balance the demands of the process and to maintain a congenial environment. Using filtros tile, this has been accomplished with as little as 0.03 cu.ft. free air per gallon per hour under 10 ft. head. This is insufficient to keep sludge in suspension. Mechanical agitation is less expensive than compressed air, which should not be used.

Factors Affecting Oxidation—Assuming agitation by mechanism, there remain to be considered and applied the factors of absorption of oxygen by sewage. Some of them are: The amount of oxygen absorbed is proportional to (1) the *area* and (2) the *time* of contact and is (3) inversely proportional to the amount required for saturation. That is: A liquor 80 per cent saturated will begin to absorb twice as fast as the same liquor 90 per cent saturated. (4) The character of film between gas and liquor affects the rate of absorption.

As a corollary to (3): The presence of unsatisfied radicles (such as ferrous iron, nitrites, etc.) accelerates the rate of absorption. These factors modify one another. For instance: If factor (1) alone were considered, dividing the air into bubbles of twice the area would double the quantity of gas absorbed, and if this resulted in doubling the period of contact, absorption would be quadrupled. This does not work out. Nordell, in his study of bubbles at Milwaukee, came to the conclusion that the smaller bubble gave up its oxygen more slowly in proportion to its area than the larger bubble. At Milwaukee also it was found that the amount of oxygen absorbed from a given quantity of air did not increase proportionally with the depth of the basin. Power economy favored the shallower basin. Although oxygen absorption may not be proportional to increase in time and area of contact, these factors are helpful and plant design should consider them.

There seems to be no factor modifying (3). Efficiency demands that dissolved oxygen be kept as low as is consistent with a healthy sludge. The microscope is the quickest means of determining the condition of the sludge. Oxygen determinations are necessary to prevent aërating beyond requirements.

The character of the surface film is of great importance. Gases passing through greasy or soapy liquors become filmed with these substances, which are resistant to the passage of oxygen. In the initial stages of aëration considerable scum is brought to the top. It should be removed from the preliminary aërator and separately disposed of. A typical analysis of scum from a strictly domestic sewage is given in Table I. This scum was taken from the primary aërator and at times amounted to 10 per cent of the suspended solids in the sewage.

The factors affecting surface aëration may be demonstrated in the laboratory, using a solution of pyrogallic acid which turns black with oxidation. The effect of a drop of kerosene on the surface of a beaker, acceleration of oxidation by stirring or rapid removal of the surface film, indicates what takes place in the aëration basins.

It is possible to measure with reasonable accuracy the area of contact between air and liquor undergoing aëration. At Mt. Vernon, when sewage was being aërated with 0.66 cu.ft. of free air per gallon under a head of 10 ft. it was calculated that the area of contact between the liquor and the bubbles was 3,500 sq.ft. The volume of liquor being aërated was 45,000 gal. per day. The period of contact, six hours. Now, if oxygen were absorbed from the open air at the same rate as from the bubble an area of 0.778 sq.ft. per gallon per day and a period of contact of six hours would be required. That is, 1,000,000 gal. would require 778,000 sq.ft. tank area! Haworth aërates 1.3 m.g.d. per acre. After making allowance for air emulsified by agitation we are forced to the conclusion that a square foot of open air is far more efficient than a square foot of bubble. Reasons need not be discussed here but without doubt oxygen absorption at the surface is important.

Catalysts Factors in Oxidation—Each of the factors which have been discussed has been established by ample research. There is another factor the value of which has not been determined: The presence of catalysts—in this connection defined as radicles which absorb and store oxygen in a condition available for the digesting organisms. It may be that this is the factor which accounts for the wide differences in aëration requirements of apparently similar sewages. Experimenters have frequently noted that some sludges "kept" better than others. The presence of ferric hydrate has been mentioned in this connection; nitrates also. These may be supplied by trade waters, such as pickle liquors, gas-house waste waters, ground waters, or may with propriety be added.

In the paper on "Fixation of Atmospheric Nitrogen," *Engineering News-Record*, March 15, 1923, p. 487, the effect of iron in fixing liquid and gaseous nitrogen was discussed. Tests have shown that ferric iron will give up part of its oxygen to sewage organisms. When the reduced salt comes in contact with the air it is instantly reoxidized to the ferric salt. Each time this happens, an amount of oxygen equal to at least 10 per cent of the weight of the ferric iron is stored in a form available for the biological demand. This reaction probably occurs many times in the process of aërobic digestion. When it is considered that the sewage itself can be made to store but 8 to 10 p.p.m. of oxygen it is evident that a small quantity of iron may play an important part in air economy.

TABLE I—TYPICAL ANALYSIS OF SCUM FROM STRICTLY DOMESTIC SEWAGE

	Wet Per Cent	Dry Per Cent
Moisture	81.04	
Fats (combined)	13.65	72.94
Fats (free)	.91	4.84
Calcium	.90	4.75
*Organic matter	3.05	16.10
*Inorganic	2.43	2.27

* Other than stated.

Dr. Buswell calls attention to the fact that when the influent sewage contained 5 p.p.m. of nitrites and nitrates the air consumption was 0.7 cu.ft. per gallon of sewage. When nitrites and nitrates dropped to 1 p.p.m. the air consumption rose to 1.4 cu.ft. per gallon. Dr. Buswell seems inclined to believe that the nitrites and nitrates were partly responsible for the differences in air consumption. If this be the fact, then they must have acted as catalysts. If we could assume such economy to be effected by nitrates, $2 worth of Chilean saltpeter would save $14 worth of compressed air. While no such economy can be expected, this lead is worth investigation. Soluble reagents should be added to the sewage as near the source as practicable.

In working out plans for the aëration of Indianapolis sewage I had to meet the question of what to do with gas-house wastes. My preconceived judgment was that they should be eliminated because of their supposed toxicity and great oxygen absorbing power. Tests conducted on sewage containing gas wastes in their greatest concentration, in parallel with tests on uncontaminated sewage, gave some surprising results. Aërobic organisms flourished in the gas contaminated liquor. When, as frequently happened, the air supply failed the straight sewage sludge died. The gas contaminated sludge survived. The gas sludge was eventually smothered by accumulation of tar but a presumption was raised that the reducing agents in the gas-house liquors acted as catalysts.

The nature of sludge organisms makes it necessary to consider one more factor, *violent agitation*. This is destructive of some of the organisms and tends to increase turbidity. It should be avoided.

This is one of the reasons for lack of success which

has attended aëration by circulation through centrifugal pumps.

II. Aëration Practice

A period of 30 to 40 minutes' detention in preliminary sedimentation is sufficient for removing the quick settling solids and a considerable part of the scum. To insure satisfactory performance all sedimentation chambers should be equipped with mechanical means for collecting and removing the sludge. No septic sludge will rise in a mechanically cleaned basin. There are two types of mechanical sludge removers which are now performing satisfactorily: (1) The revolving type. This is the Dorr clarifier. It operates in a cylindrical basin, the bottom of which is slightly coned. The settled solids are moved to the center of the basin by a slowly rotating mechanism and thence removed by appropriate means. Milwaukee has adopted the Dorr clarifier after experiments covering a number of years. The second method consists of a submerged flight conveyor operating in a long and narrow basin. When properly designed, both these types perform perfectly. Neither requires more attention than an eight-day clock. Power consumption will not exceed ½ hp. per m.g.d. capacity. For small installations first costs favor the flight conveyor. When its unit capacity is reached, the clarifier has the advantage as its capacity may be increased by enlarging its diameter without proportionate increase in first or operating costs.

TABLE II—COST OF COMPRESSING AIR

(1) No. 3 Hytor, compressing 350 cu.ft. per min. to 5 lb. requires 10 hp., equivalent to 10 kw. at the meter. Power cost to compress 500,000 cu.ft. in 24 hr. @ 2c. per kw.-hr.	$9.12
(2) No. 8 Hytor, 2,250 cu.ft. per min. to 5 lb., 97 hp. (97 kw.) Power cost to compress 3,250,000 cu.ft. in 24 hr.	46.56
(3) No. 5 B. F. Sturtevant positive-pressure blower, delivering 696 cu.ft. per min., 28 hp. (28 kw.) Power cost to compress 1,000,000 cu.ft. in 24 hr.	13.44
P. H. & F. M. Roots Co. blower, power cost to compress 1,000,000 cu.ft. in 24 hr.	10.56
Adding interest and amortization at 20 per cent per annum, transmission, motors, housing, maintenance and supervision, the costs of compressing 1,000,000 cu.ft. free air to 5 lb. will approximate:	
Nash No. 3 Hytor	20.00
Nash No. 8 Hytor	15.00
Sturtevant No. 5 positive-pressure blower	15.00
Roots blower	12.00

Economical Application of Compressed Air—Filtros tile has been the medium generally adopted for diffusing compressed air. Distribution of the tile and control of circulation are important. Proper placement of the tile may result in an air economy of from 20 to 40 per cent. The plants at Urbana and Mt. Vernon required an average of less than 1 cu.ft. of free air per gallon of sewage treated. At Urbana, an earlier activated-sludge plant using a different distribution of filtros tile required 2 cu.ft. of air per gallon.

At Indianapolis the same theory of circulation was applied. This unit operated in parallel with one of the conventional type. By the conventional type is meant rows of tile laid across the aëration channel at right angles to the direction of the flow. In the improved method the tile are laid along one side of the channel in rows parallel to the direction of the flow. An example of this type is the Woodstock, Ont., plant, designed by F. J. Ure & Son, Woodstock. Messrs. Ure report that this plant is operating satisfactorily with a consumption of 1 cu.ft. free air under a head of 12 ft. The cross-row method of laying tile prevents any definite vertical circulation and encourages short circuiting. The improved method insures positive circulation, prevents short circuiting and reduces the area of filtros required.

Costs of Compressing Air—Cost data have been supplied by manufacturers of compressors as shown by Table II. Larger size units will reduce these figures somewhat. Economical use of power requires adjustment to meet varying seasonal and weekly conditions. This means the installation of two or more units, even if variable-speed motors are used. For cities under 100,000 population small compressor units would be required and the table figures would hold. If the flow sheet suggested in this paper be followed and air supply be adjusted to requirements, average municipal sewage can be aërated the year round with an average air consumption less than 1 cu.ft. per gallon under 10-ft. head.

TABLE III—ANALYSES OF DRIED ACID-TREATED ACTIVATED SLUDGES

	Per Cent
Mt. Vernon, N. Y.	
Moisture	9.25
Ammonia	8.79
Bone phosphate of lime	7.70
Insoluble	13.50
Ferric oxide	9.95
Calcium oxide*	5.92
Magnesium oxide	.13
Houston, Tex.	
Moisture	5.74
Ammonia	7.75
Bone phosphate of lime	5.66

* Included also in bone phosphate of lime.

Other Methods of Aëration — Aëration through centrifugal pumps, inspiring and mixing the air directly with the sewage, has been tried at a number of places. One of the latest commercial installations of this type is at Turlock, Calif. There are several patents on different ways of applying this principle. Diffusion of air by this method is ideal. Power consumption is low. The disadvantage has already been mentioned.

"Paddle aëration" has been under development for a number of years. Three types have been used: (1) Haworth places his paddles in narrow channels at right angles to the flow, like a stern-wheel steamboat. (2) The Stott & Jones patent paddles rotate axially with the flow of sewage and create a helical direction of travel, similar to that of the Ure filtros design. This should be more economical of power than Haworth's design. (3) In the Borst patent the paddle hangs vertically in a cylindrical tank. All three of these methods have produced satisfactory effluents. Some very low power consumptions have been reported. There is another method which is a cross between centrifugal and paddle circulation. This consists of a cylindrical tank with a central well of fairly large diameter. The central well is expanded at the top to form an inverted cone. A paddle with a vertical axis is operated in the cone close enough to the surface to beat air into the sewage. Mixed air and sewage overflow the cone and bottom liquor is drawn up to take the place of the overflow. Some of these paddle methods have had sufficient success to induce their commercial adoption. This indicates that in some localities the paddle method is considered more economical than the compressed air-filtros method. My own experience with paddle aëration leads me to believe that this is the method of the future. Plants of this type can be made so fool-proof and simple that aëration will require only casual supervision and night attendance be eliminated.

Paddle aëration has been developed to a point where it demands the consideration of the engineer contemplating plant design to produce a clear and stable effluent. Aëration units can be designed to be convertible to filtros aëration without loss of first cost. If paddle aëration produces satisfactory results, it means a cheaper plant and lower operating costs.

III. Sludge Handling, Dewatering and Marketing

Discussion of sludge disposal may be divided into: (1) Factors affecting cost of disposal. (2) Factors affecting value of product. Since value may be affected by preparation methods they are discussed first.

The valuable constituents of dried activated sludge

TABLE IV—DEWATERING BY PECK FLOATING PROCESS

These figures are averages covering 2½ weeks testing period.

	Per Cent Moisture
Influent sludge	99.4
Floated sludge	89.2
After draining one day	77.1
After draining two days	66.5
After draining three days	59.7
After draining three weeks	26.4

are phosphoric acid and ammoniates. Where care is taken in preparing the sludge for market it should contain from 3 to 4 per cent of bone phosphate and from 7 to 9 per cent of ammonia. The analyses of two sludges dried by commercial processes are given in Table III. Ordinary dried activated sludge contains from 4 to 6 per cent of ammonia and no other constituent in sufficient quantity to be of value.

The chief factor affecting the value of the dried sludge is its proportion of valuable constituents. Drying and handling costs for the inert portion are charged against the valuable portion. Example: Assume that methods which disregard the character of the sludge produce one ton of 4 per cent ammoniates per million gallons sewage treated, and that the cost of drying the sludge is $15 per ton and freight and handling charges to destination are $5. The cost of sludge disposal is $20 per million gallons. *If* by exercising care in eliminating inert materials, one half ton of 8 per cent ammoniate is produced, the cost of sludge disposal is reduced to $10. This is the reason why, when high-grade ammoniates are quoted at $4 per unit, low-grade may be marketed with difficulty at $1.50 to $2.

Activated sludge is unknown commercially. For this reason brokers will not pay market price for its fertilizer constituents. Market quotations should be discounted 25 per cent in estimating the product's value and should not be taken to mean those given in trade magazines as obtaining at Chicago, New York, Baltimore, or any other trade center. They mean the quotations of the nearest market which will absorb the product. For cities of less than 200,000 population this should be within trucking radius of the plant. Local sale will save *round trip* freight to fertilizer plant, broker's and manufacturer's profits. Specifically, it should obtain 50 per cent better price than brokers will pay.

The consumption of fertilizer is seasonal. Storage reservoirs must exist somewhere between production and use. For most crops dried activated sludge is not a balanced fertilizer. It must be used as a base. Crop tests indicate that it is a slow-acting ammoniate. This brief review indicates the necessity for a careful survey of markets.

Factors Affecting Costs of Disposal—These are two: (1) The quantity of sludge produced. (2) The character of the sludge. The quantity of sludge can be controlled within considerable limits. Excessive aëration decreases the quantity of the sludge. It also lowers the grade of the sludge produced. High-grade sludge will certainly sell for more than the cost of preparing it for market. Elimination of grit, coarse solids and flotable solids from the sewage insures a high-grade product. Slow and sparing aëration means a double economy, more and better-grade sludge, an effluent lower in nitrogen and less power expenditure. As by-products with high-grade sludge there must be disposed of: The floated and settled solids from preliminary sedimentation, grit and screenings. The last two will be disposed of by the usual means. Preliminary sedimentation solids will contain on a dry basis, 4 per cent ammonia. The amount will be 200 to 400 lb. dry solids per million gallons. Gassing or acidulating and draining to 70 per cent moisture will cost $1 per million gallons sewage. The scum will range from 50 to 100 lb. dry solids and will drain to 75 per cent moisture. In this condition it will contain about 19 per cent grease. It has no value and may be disposed of by incineration or lagooning at a cost of 50c. per million gallons sewage.

The character of activated sludge is such that until recently it has defied all attempts at commercial drying. High-grade sludge is essentially a biological jelly. Chemically and physically it is closely allied to gelatin. Like gelatin it cannot in its normal condition (bicarbonate alkalin) be dewatered by pressure. When rendered slightly acid its character is changed and it may be readily drained to 60 per cent moisture. Three methods have been developed for successfully applying

TABLE V—COST ESTIMATES FOR COMPLETE 1-M.G.D. PLANT

Estimated cost of completed plant	$64,011	
Daily operating costs include interest and amortization at 10 per cent. Compressed air-filtros aëration included. Paddle aëration would reduce first cost $10,000 and operating costs $5 per million gallons.		
Estimated operating cost	$44.25	
Apportioned as follows:		
1. Racks	.58	
2. Raw sewage sedimentation	2.13	
3. Aëration	15.73	
4. Aërated sewage clarifier	1.63	
5. Preliminary dewatering	7.24	
6. Sludge circulation	1.66	
7. Drying	8.63	
8. Supervision (city engineer)	3.60	
9. Miscellaneous	3.15	
Total gross cost per million gallons treated		$44.25
Sale of dried sludge		20.80
Net cost of treatment		$23.45

this principle. (1) Floating, developed by the writer. (2) Gassing, developed by The Maclachlan Reduction Process Co. (3) Vacuum filtering, developed by the Oliver Filter Co.

My first experience in dewatering sludges by floating was in 1916. The sludge was a gelatinous precipitate from hide treatment waste waters. Upon adding sulphuric acid, the sludge rose to the top, where it drained to about 80 per cent moisture. In this instance, the method was too expensive for commercial application. Later, in designing the Mt. Vernon activated-sludge plant, I included a "frothing tank," intending to separate the sludge in this manner. Sludge floating tests in this tank were unsuccessful. In the laboratory, agitation with sulphuric acid resulted in floating about one-third of the sludge. On gentle stirring this sank. Mr. Neave and I continued our sludge dewatering research at Urbana. Here we found that if the acid and the sludge were mixed with but little agitation and then gently heated, *all* the sludge would rise to the top. The Urbana activated sludge when settled to 99 per cent moisture indicated an alkalinity of about 450 p.p.m.; 1.5 c.c. of sulphuric acid per liter was required for successful floating. The floated sludge contained from 84 to 90 per cent moisture and drained in a few hours to less than 80 per cent moisture.

J. Frederick Jackson, chief of the Engineering Divi-

sion of the Connecticut State Department of Health, used one of my floating units at New Britain. Using 1 c.c. of sulphuric acid and heating to 30 deg. C. he obtained the results given in Table IV.

The drying sludge was at all times odorless and free from insects and larvae. Dr. Jackson states that with proper operation the water discharged from the floater contained less than 100 p.p.m. of suspended solids and under 10 per cent of the original nitrogen.

In this connection it may be stated that some activated sludges seem amenable to *flotation*. By flotation is meant the separation due to selective affinity of gas bubbles for certain solid particles. Where such affinity exists, bubbles admitted to the liquor will seek out the particles for which the affinity exists, attach and float. Activated sludge in general does not adhere to gas bubbles. It may be floated only by *entrapping* gas bubbles in the sludge, making them rise en masse.

Maclachlan's process has already been described. It is in successful operation at Gastonia, N. C., in connection with a plate and frame press. The dewatered cake averages about 78 per cent moisture. At Houston it is operating in connection with the "decker" (the dewatering screen described above). The product contains about 80 per cent moisture. The remaining moisture is evaporated in a Buckeye drier. It is estimated that the cost of dewatering to an average of 83 per cent moisture will be about $6 per ton of finished product, equivalent on the basis of 1,300 lb. of dry sludge per million gallons to $3.90 per million gallons of sewage treated. This estimate includes all maintenance and depreciation charges.

Milwaukee proposes to use heat and acidulate and dewater with Oliver vacuum filters to 80 per cent moisture, finishing in direct or semi-direct heat driers. Indianapolis and Pasadena have awarded contracts for the Maclachlan process.

Cost comparison of the dewatering processes would at present be guesswork. The unknown factor is depreciation. Allowing for heavy depreciation and, in the case of the Peck process, for further drainage and handling, the cost of dewatering to 80 per cent moisture by any of these methods will not exceed $6 per million gallons of sewage treated. The proponents of any of the processes probably will not admit half that.

Drying to the ultimate 10 per cent moisture can be accomplished in direct heat driers. One pound of coal will evaporate 6.5 lb. of water. Power, supervision, depreciation, interest and other changes will not exceed the cost of coal. Losses will be under 5 per cent. If 1,000,000 gal. of sewage be assumed to produce 1,200 lb. of activated-sludge solids and coal in the furnace costs $10 per ton, the costs of evaporation will be $7.20 per million gallons of sewage treated. If the methods described above are followed the product will be 1,300 lb. of 10 per cent moisture, 8 per cent ammonia and 4 per cent B.P.L. (bone phosphate of lime) fertilizer base. If this can be marketed at $3.50 per unit for ammonia and $1 for B.P.L. the value of the produce will be $20.80.

The estimate in Table V is based on unit costs of $25 per cubic yard for reinforced concrete and $2 for excavation, with excavation equal to half the cubic contents of plant. The plant is rated as 1,000,000 gal. per day capacity. It is expected to discharge a six days' stable effluent when operated at a daily 3-hr. overload of 100 per cent and a constant overload of 25 per cent.

Building a Dam in Bolivia

A View of Native Labor and an Exposition of North American Engineering Ingenuity

By R. A. Bennitt

Of Bennitt & Sawyer, Engineers and Constructors, La Paz, Bolivia, South America

CONSTRUCTION in the Andes Mountains is little like construction work in the States. High prices of materials, when they are available, bring into play all one's resource to keep costs down. Native labor is peculiar to handle and understand and its methods are more or less laborious. These factors are often complicated, as they were in the case at point, by the remoteness of the job, the rough character of the country and the scarcity of local materials. How such a job is tackled is outlined in this article, which treats of building a dam 15,200 ft. above sea level.

The dam was built to furnish additional power to operate the mines and mill at the Chojñcota tin mines, controlled by the Metals Thermat Co., of New York City. Chojñcota is situated in the province of Yaco, approximately 100 km. from a railroad, at an elevation of 15,200 ft. and derives its name from Lake Chojñcota (Aymara, or Green Lake). This lake, about 30 acres in area, and used as the reservoir for the water impounded by the dam, is fed by the glaciers 2 km. away. However, in the dry season insufficient water is furnished to supply the needs for power—about 4 sec.-ft.

The power house built in 1915 can develop 230 hp., but under the present scale of operations but 140 hp. is used. Of this 75 hp. is used by the concentrating plant and 65 hp. by the compressors in the mines. As the shortage of water precluded operating more than twelve hours per day during the dry season, it was decided to raise the existing dam an additional 4½ m., which would give a storage of 840,000 cu. m. and allow an additional draw-off of 2 sec.-ft. for twenty-four hours during the six months of dry weather.

The dam site is a narrow rocky gorge at the foot of the lake, whence the floor of the cañon pitches steeply. No flow conduit was necessary, and the 12-m. steel penstock therefore drops directly to the power house with a gross head of 560 ft.

Securing Materials—By far the greatest cost on construction work in this part of the world is for materials, and for that reason it was decided to build the dam of rubble masonry. Quartzite beds in slate on either side of the cañon settled the rock question, but peculiarly enough sand is difficult to secure because of the swift-flowing streams. However, after a sieve analysis, it was decided that the fine sand deposited at the head of the lake would be suitable if screened. Accordingly a small washing and screening plant was built which passed the finer sand particles through a .005-m. mesh.

To transport the sand to the dam site a flat-bottom scow was built into which were loaded bags of screened sand. But when the "Mauretania" was launched it was discovered that the personal equation had been lost sight of, for no native dared row a boat across the lake! They are not accustomed to water in any form, but being good laborers, *i.e.*, with strong backs and weak minds, they would tow it. A long rope and a lashed rudder solved this problem.

Description of Dam—The dam was laid out on a curve with a radius of 210 ft., except for a short straight sec-

tion over part of the old dam; and an angle was made at a 16-ton anchorage so to locate the west wing as to require the least amount of masonry. The upstream face of the dam was made vertical, and the downstream face given a batter of 0.6:1. A coping wall, 0.5 m. x 0.5 m., was provided, in which was built a small spillway with provisions for flash-boards to within 2 in. of the top of the coping.

The cross-section of the dam was determined from calculations as a straight gravity section for hydrostatic pressure only, giving a nominal factor of safety against overturning of 2.3, no allowance being made for uplift, wave action, or ice pressure. However, the utmost care was exercised in preparing the rock foundation against leakage and sliding.

The mortar used was one of cement-lime (10 per cent of the volume of the cement being slaked lime) to four of sand. This mix will probably seem to many one containing an inadequate proportion of cement to prevent seepage, but the writer believes it justifiable under the conditions. Cement on the job cost about $17 U. S. currency per barrel, and the cost of other materials was in proportion. The dam now stands reservoir full and with but slight percolation, which is gradually lessening. From time to time corral sweepings are thrown into the water to silt up the voids in the mortar, reinforced, as it were, by the old "popcorn-popper" method.

Rock for the masonry was blasted out nearby and rolled to position on a "go-devil" running on a 24-in. Decauville track. All of it was handled by hand with the aid of crowbars. Boulders weighing 2½ tons were shoved into position by this method, but a cable-way with a chain-block was later installed and proved to be more economical of time and labor.

Unique Transportation—This cable was 1¼ in. in diameter and 800 ft. long and was brought from the mill-site on the shoulders of twenty men. Long cables brought in from the railroad to various mines in the mountains are frequently carried entirely by mule-back. A section of cable weighing about 250 lb. is rolled and packed on a mule at the head of the recua (mule train), then the cable is carried back about four paces and rolled further, etc., so that the cable finally arrives at its destination in one piece. No arriero (muleskinner) would dare pack a mule or burro without first binding his scarf or poncho over the beast's eyes. If asked why the animals are broken thus, he will probably merely say, with a shrug of his shoulders, it is the "costumbre."

FIG. 1. COUNTRY IN WHICH DAM IS LOCATED

FIG. 2. MASONRY DAM AT ELEVATION OF 15,200 FT.

In building masonry work one wonders how the Incas and their predecessors, the long-extinct Chulpas, managed theirs. The writer has seen remains of their work—rocks weighing up to 80 or 100 tons placed without cementing material of any sort, with the joints so skillfully made that the blade of a penknife cannot be inserted. Furthermore, the blocks of stone are not square but may have as many as ten or twelve angles, all parts touching the adjacent stones with equal exactitude. The material of which this massive masonry is composed must have been transported a great distance for the surrounding country has not the same stone.

Labor—The labor used on the job was pure Aymara Indian and the Cholo, or mixed breed. These people, though not as efficient or as intelligent as skilled and unskilled labor in the States, are fairly steady and faithful, and are easily worth what they earn. They have the custom here, and also in Peru, of stopping work for fifteen minutes at ten in the morning and three in the afternoon to chew coca, or "acullicar." Each coca leaf is taken separately, pulled from its main stem with the teeth until the cheek is enormously distended. A bite of mild lye gives it more "kick." Then the laborer pulls out his native cigarette for a smoke. This cud reposes thus for a couple of hours, the resulting liquid which is swallowed, giving renewed energy and strength.

The wages of these people are ridiculously low but they save up just enough after paying for their chuño, charque, and rice to have a glorious spree on 40 per cent alcohol when one of the numerous fiestas comes around. Chuño is a dessicated potato and charque is a mummified

sheep, which, together, make great soup if you like it. The ordinary peon earns 65 cents to 75 cents per 10-hour day, a mason $1 to $1.20, a driller 90 cents to $1, etc., the average for the entire job being 90 cents per man day. Seventy per cent of the total cost of the work was for cement, lime, and other materials, and the entire cost per cubic meter was $11.85 or say $9.10 per cubic yard, including supervision. This compares favorably with concrete costs for similar work in the States. About ⅔ bbl. of cement per cubic yard of masonry was used, which was possible only because of the lean mortar, the use of large rocks, not dressed, and the care taken in placing them.

The "Bolivian Railroad"—Materials for the interior of the mountains are usually packed in small packages in order that they may be carried by llamas, sometimes called "the Bolivian Railroad." The llama will carry 100 lb. and no more, so that if he is loaded to exceed his capacity he will simply lie down on the trail until relieved. They travel about 20 km. per day in droves of twenty to two hundred. At about five in the afternoon their Indian drivers remove the packs and the llamas graze wherever they list. Often they stray to some pretty high peaks, so that the following day although their native keepers arise before the sun, it is usually ten o'clock before they are again on their way. After collecting their animals they are huddled close together with a long rope making a large ring so that they can not stray away while being packed. A couple of thicknesses of wool blankets are thrown over the woolly backs, then two packs aggregating 100 lb. are fastened on by another wool rope run under the llama's belly. All cement and lime for the job was sacked at the railroad and transported in this manner, taking five to seven days to cover the 100 km. The native Aymara or Quichua Indian makes an excellent llamero for he has great patience, and the speed of his mind and body synchronizes very well with the speed of the llama he drives.

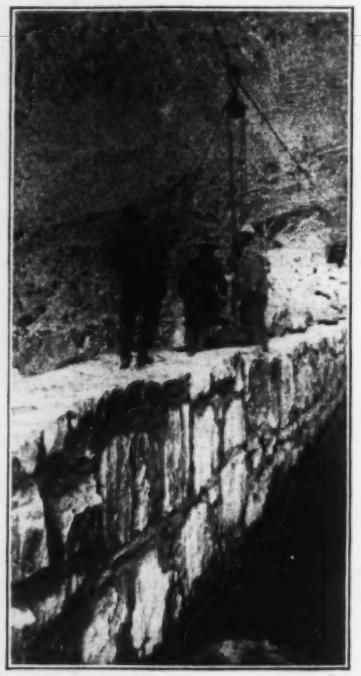


FIG. 3. SETTING ROUGH STONES IN THE DAM

A sketch of this sort would not be complete without telling something of the climate. From April to October is the dry season in which most of the days are beautifully bright and sunshiny, with very cold nights in which the temperature drops to 0 deg. F., and the piercing blasts from the glaciers and the rare atmosphere will cause one considerable discomfort if he be not warmly dressed. The rest of the year is a season in which fogs, sleet, rain, and hail are always in order. Intermittent sunshine will quickly give way to heavy overcast skies with a subsequent downpour of rain or hail, usually accompanied by a raw wind.

Handling a construction job in the Andes Mountains presents many difficulties, but they are part of the game which an American engineer working in foreign parts is obliged to play, and at the end he can look upon his work with pride as a good job well done.

Progress on the Chicago Plan

By Eugene S. Taylor
Office Manager, Chicago Plan Commission

THE year 1922 marked the thirteenth year of activity on the part of the Chicago Plan Commission, and also the thirteenth major accomplishment on the "Plan of Chicago." Created in 1908 under the auspices of the Commercial Club, the "Plan" was recognized as the most comprehensive and most beneficial city plan that had been conceived up to that time. Today it still stands supreme and has furnished the inspiration for the modern development of nearly 200 American municipalities.

The various projects in the Plan of Chicago are intended primarily to make Chicago a better place in which to live and work. They have an equally beneficial result, however, in that they will increase the health, happiness, contentment and prosperity of our people.

Nearly every improvement in the Plan of Chicago has both a humanitarian and a commercial aspect. The humanitarian effect of the creation of 1,138 acres of parks, playgrounds, bathing beaches and boulevards along the lake front, and of the acquisition of 25,000 acres of country playgrounds or forest preserves encircling the city, is obvious. Their commercial benefits are not so plain, but they are just as real. The commercial advantages of the various street widenings and the railway terminal rehabilitation are self-evident. Their social benefits are not so apparent, until study reveals that the improvement of thoroughfares and of transportation facilities will make it easier for the dwellers in overcrowded districts to reach the lake front, the various parks and the forest preserves. At the same time these improvements add to the comfort of all our citizens, promoting their convenience in moving about the city, and adding to their health and well-being by increasing the amount of available light and air.

Projects now under way or in contemplation include nearly a score of widenings and improvements on important streets, the forest preserve, good roads, harbor facilities, park and lake front improvements, railway terminals, straightening the Chicago River, double-deck improvement and dock on South Water Street, a west-side warehouse district and the zoning system. The completion of these projects and of other betterments proposed in the Plan of Chicago is essential if Chicago is to maintain its present leadership.

Fire Loss in New York State

In a recent bulletin issued by the National Board of Fire Underwriters, the fire loss in New York State during 1921 amounted to $48,391,992, a figure far exceeding the loss sustained in any other state in the Union during the same period. The largest single share of this loss was the item of "matches-smoking", which contributed $4,099,993. The total loss represents an increase of 33 per cent over the loss sustained in 1918.

Engineering Course Should Stress Scientific Training

Dean Ketchum Favors Four-Year College Course with Graduate Courses for Advanced Work—Teachers Are Vital Factor

Abstract of address delivered March 7, 1923 on his induction into office as dean of the College of Engineering of the University of Illinois.

By Milo S. Ketchum
Dean, College of Engineering, University of Illinois

TODAY the engineering profession demands that the student be trained intensively in engineering science so that he may be able to keep pace with the development of engineering and of scientific research. Industry demands that he be trained in the art of engineering and prepared also to enter the field of management and administration. In the time available it is practically impossible to give the student the intensive training of the professional engineer and at the same time the broad training to make him of immediate value to industry. Engineering educators are divided into two groups with respect to this question. One believes in a training in physics, chemistry, mathematics, language and economics, with intensive training in the fundamentals of engineering and in the application of science to engineering problems. The other believes in a broader course, including the humanities and business administration, to make the graduate of greater immediate value to industry and to the community. In such a course, the application of science to engineering is considered more from the viewpoint of the administrator and is intended to be a broadening influence rather than to make it possible for the student to solve engineering problems. The aim is more to qualify men to be leaders in industry than to train them for the profession of engineering.

Shall We Seek Breadth or Depth?—The usual four-year course does not give sufficient time to develop either of these satisfactorily. Additional time may be gained by increasing the course to five years or by adding a graduate course in engineering. Although it was possible formerly to accomplish both these objects in a four-year course, the development of engineering science and of business administration has made this impossible. The result of such an attempt will be to give the student a smattering of information, with little training that will prepare him either for engineering or for industry. We must, therefore, choose between a training that is narrow and deep, or one that is broad and shallow. Few can excel in more than one line, and those that can are marked men. The question is, shall we plan a course to give a broad training so that students will be able to do many things in a very indifferent fashion, or shall we limit our work to the training of men for the profession of scientific engineering, leaving to other departments the training of those who expect to enter business or administration immediately after college?

Education is a gradual development and is the summation of training in the home, in the elementary and secondary schools, in the university, in business, in professional life, and of the best effort of the individual. The successful man must not only have the training that will make it possible for him to appreciate art, literature, and his associations, but he must be able also to achieve—to do his share in carrying the world's burdens. College training should be intensive, should teach the student how he may best perform with his brain, and give him an appreciation of what it means to excel.

Five-Year Course Not a Solution—Engineering is a constructive profession which calls for intensive training and perspective, the lack of which cannot be remedied by increasing the length of the course. The proposed plan to spread the engineering course over five years, omitting the intensive engineering subjects, and adding certain so-called humanistic subjects and other subjects intended to prepare the graduate for administrative positions, does not solve the problem. If the profession is to advance and the demands of industry are to be met, the course must prepare the graduate with a training and a vision to be a leader in his profession. If he has this, and in addition, those essentials of industry, character, integrity, knowledge of men and administrative ability, which the successful must have whether they are college graduates or not, he will be a leader in his profession and will have opportunity to become an administrator or a leader of men.

Success as an engineer will be due largely to the intensive training while in college and success as an administrator will be due largely to success as an engineer and individual effort. This opinion is based on an experience of more than a quarter of a century as an engineering educator, a practising engineer, a contractor and as an administrator. The most successful men trained under my direction or who have come to my notice or have been in my employ, whether in engineering, business or administration, have almost without exception been those who have excelled in their technical studies, who have learned to think straight, who have come to appreciate what it means to accomplish and excel.

Research in Engineering—The engineer engaged in research should have a thorough theoretical training in the sciences, in mathematics, and in mechanics, should also have had a practical engineering experience and should have been trained in scientific methods of investigation. Engineering research and engineering experience co-operate in advancing the science and art of engineering. The engineering student should not only be given training in the underlying sciences, in mathematics, in mechanics, and in the fundamentals of engineering, and briefly in the art of engineering, but he should also be given an insight into the methods of the worker in engineering research and appreciate the necessity for engineering research. He should not only be trained to enter the profession of engineering, but should also be given a vision that will make it possible for him to become one of the leaders of engineering and of industry.

Summary—To sum up; the preliminary training of the engineering student should include intensive training in language, mathematics, history, civics, and science. The engineering course should be four years in length. The curriculum should include courses in science, mathematics, mechanics, the fundamentals of engineering science, and the practice of the art of engineering. Special emphasis should be placed on training in engineering science and some attention should be given to fundamental courses in economics, business law, and government. For men who wish to enter the higher branches of technical engineering, who wish to become engineering teachers, who are to engage in engineering research, a graduate course should be provided, the length of which should vary from one to three years to fit the needs of the graduate student. As an inspiration to the student and to the instructor and to assist in training teachers and graduate students, the college of engineering should engage in engineering research. The most satisfactory and efficient development of each will come from a combination of undergraduate work in engineering, graduate work in engineering, and engineering research.

Importance of the Teacher—The most important part of any institution of learning is the teacher. The engineering teacher should be a man who has had a liberal education as well as a thorough training in mathematics, mechanics, science and applied science, and in addition should have had engineering and business experience. Much of the training in a knowledge of business affairs, in a knowledge of men and in the application of economics to industrial problems and in ethics, must be given incidentally. After all, the greatest privilege given to the college student is that of coming in direct contact with men who have given their lives to literature, economics, science, mathematics or engineering, who live in their work and to whom the greatest joy is assisting students to unlock the storehouse of knowledge.

Some Obligations of Research on School and Industry

Research Needed to Impress Students with Lack of Finality in Engineering and to Urge Industry to Further Progress

Extracts from an address entitled "Importance of Research to the Progress of Industry" at the induction into office of Milo S. Ketchum as dean of the College of Engineering of the University of Illinois, March 7, 1923.

By E. J. Mehren
Editor, *Engineering News-Record*

THE pursuit of knowledge, the discovery of truth, has ever been one of the goals of university activity. The mere prospect of increasing our knowledge has been incentive enough for the aspiring spirits that the universities have gathered to their fostering arms. But if the mere pursuit of knowledge for its own sake offers sufficient incentive for scientific research in the halls of learning, the university nevertheless cannot be neglectful of the practical results; for the university has a responsibility for social, as well as for intellectual, leadership. Our social system today rests largely on an engineering and industrial foundation. Anything that will improve and develop that foundation is properly a subject of university responsibility.

To us, as engineers, there are more intimate considerations; considerations that have a profound influence upon the spirit that must animate the college. If research is a *sine qua non* of engineering and industrial progress, if, in turn, the college of engineering exists as a servant of engineering and industry, supplying it with the men who shall carry on in the future, it is the bounden duty of that college to cultivate the research spirit and to turn out its men imbued with that spirit, imbued with the belief that there is no finality in engineering development.

Fifty years ago the fundamental assets of industrial success in this country were daring and energy. We lived in a veritable gold mine. Resources were of unparalleled richness. Little skill was needed to wring success from such natural assets. That was the day of the adventurer in industry, of the promoter, of men of shrewdness rather than of broad or intensive knowledge.

Today, how different. The best of organizing brains, the greatest of financial resources, the most versatile of salesmanship are not sufficient of themselves to build industries. There must be knowledge, abundant knowledge of intricate industrial processes. The richest resources have been worked out. Profit must be wrung from poorer materials. Today, as never before, knowledge is power, and industrial knowledge, at the present stage of engineering development, is, more and more, a direct function of scientific research. Some industries are farther advanced than others. Success in many industrial operations can now be won only from the introduction of great refinements, from the development constantly of new materials and new products, from the discovery of processes which shall give value to the materials which were useless under cruder processes of recovery.

Researches of the recent past give us courage for the future. We could easily become discouraged by contemplating the rapid exhaustion of our richer resources. We could worry about the future of our children's children. Were we at the stage of scientific development of a hundred years ago and were witnessing the present rate of depletion of our richer resources, we might well be seriously disturbed. As it is, it behooves us as responsible members of a world civilization to use those resources to the utmost possible efficiency. Nevertheless, we can look with more complacency on the situation than our predecessors, for we have at hand an instrument that each year discloses as valuable treasures, materials and resources that formerly were valueless.

Obligation of the University—If then scientific research has come to occupy a place of such great importance in our daily lives, if the maintenance and further development of the material elements of our civilization are dependent upon new scientific discoveries, if the industries of today and those of the future rest upon the work of the research laboratory, it is manifestly the obligation of the engineering college, whose work it is to prepare men to carry on the work of applied science, to see that they are imbued with this spirit of research.

It is not to be expected that every student leaving the college of engineering should be adapted to research work. The processes of engineering are complex. They require men of many types, of varied inclinations, of widely different adaptabilities. But all who leave these engineering halls should be thoroughly imbued with the idea that there is no finality in engineering development. Some will engage in research work and develop new materials, new processes, new principles; some will engage in design, and, accepting principles already established, will work toward greater economy, greater efficiency within the range of those principles. Others will be responsible for the operation of the processes of production. All, however, even though they may be unable to engage in research work, and no matter what positions they may occupy, must be sympathetic with the spirit of research, must encourage it, must lend it their support, must help to place it in its proper place in the structure of American business.

Obligations on Industry—There is needed throughout the business organization of the land a better appreciation of the function of research. While some industries have gone far in introducing scientific inquiry into their businesses, while a very few of them are resting their whole operations on a research foundation, most of our industries are not beyond the stage of crude experimentation. If university men do not lead in advocacy of research, whence indeed shall come its friends? Our goal must be a "mutual deep appreciation," as one scientist has expressed it, between American industry and American science.

Nor can we be content with merely impressing upon the leaders of American industry the need for and the utility of such research as is associated with the solution of immediate difficulties in manufacture or the necessary improvement of a product. Our task, with our broader vision, should be to point out the necessity, if our industries are to continue to progress, to push inquiries of a fundamental nature, not necessarily connected with immediate prospective utility. Radical progress can be expected only from a thorough knowledge of the materials and processes with which we work. When their nature is thoroughly understood, then occur those radical advances which shoot a science or an industry into a new era and open radically new fields to scientific inquiry.

In advocating the necessity of fundamental research, we need to break down the distinction that some attempt to make between engineering and scientific research. Engineering research, it is held, is that directed at immediate results; scientific research relates to the fundamentals. The theory is that one is useful, the other is not. We have many instances to show, as Dr. Steinmetz has put it, that "there is no scientific investigation, however remote from industrial requirements, which might not possibly lead to industrially useful developments." Our task, as university men, is to promote the fundamental researches as well as those that have an obviously practical end.

We should find encouragement, too, in our efforts to secure the general adoption of research in industry because the American industrial leader so far senses the need for progress that he accepts crude experimentation as a necessary feature of industrial functioning. But he needs to be convinced that the bungling of the rule-of-thumb experimenter has passed, and that science furnishes a superior tool through the research mechanisms of mathematics, physics, chemistry and engineering.

Research and Instruction—It is not my function today to discuss the means by which this spirit of research can be impressed upon the students of engineering. Obviously, it requires something in addition to instruction in the established principles of engineering, mathematics and physics

and in their applications. Nor is it sufficient for the student to learn that it is by an intensification of the methods that he sees about him in the laboratories that new knowledge is to be discovered. It is from the spirit of the institution, rather than from any direct teaching that appreciation of research is to be gained. Capable research men must be pushing their inquiries within the university walls where students can see and know them and absorb the spirit in which these leaders are working. Teaching by example is most powerful. Enthusiasm for painstaking scientific inquiry is the surest means of spreading the gospel of research.

Obviously, there are many problems to be considered in determining the relation of the university to industry with reference to research work. I do not propose to enter upon them today. The two obvious fundamentals are that industry has an obligation to give financial support to research work, and that the university has an obligation to further research work that shall result in engineering progress. There is needed a combination of industrial financial support with university vision and ability—a combination well realized in our own Engineering Experiment Station. Such a station will be a breeder of independent laboratories in industry, but if the university keeps its vision there will always be work ahead, particularly in the fundamentals, no matter how many industrial laboratories are established.

Insufficient Utilitarians—It would be unworthy of a university were its research, were its pursuit of knowledge inspired solely by the hope of useful result. Utilitarian ideals, if indeed they may be called ideals, are weak in power of inspiration compared with those that are intellectual and spiritual. The university is indeed a place of training for life—but for life in its larger and finer aspects. Moreover the university is a place of light and of leading. Its duty is to bring our knowledge to ever loftier heights and to breed not merely good workers and good citizens but creative leaders, those prophets who shall lead us to new promised lands. Such creative men, the finest flower of university effort, "arise spontaneously in an atmosphere in which creative men exist and, in general, nowhere else." This atmosphere is the sure strength of the university. It is that which distinguishes it from a mere place of instruction.

With this thirst for knowledge at the basis of university enthusiasm for research, utilitarian research will not only have a surer foundation but will be immeasurably strengthened by contact with the purer enthusiasm. Young men and young women will be led to new visions by acquaintance with the explorers of knowledge, adventurers into the unknown. Youth loves exploration and adventure — and research is exploration, research is adventure.

This, then, is the inspiring mission of the university—to stimulate the thirst for knowledge, to develop creative men and women, to send out with broad vision and sympathies the leaders in life's activities.

Present Extent of Railway Electrification

At the recent convention of the American Institute of Electrical Engineers in New York, W. P. Potter, engineer, railway engineering department of the General Electric Co., offered the following table, showing the present extent of railway electrification. This includes only steam railroads which have been electrified or are now in process of being electrified.

Country	Route Miles	No. of Elec. Locomotives
United States	1,607	375
Switzerland	661	156
France	602	338
Italy	650	309
Germany	550	49
Sweden	237	44
Cuba	180	18
Austria	340	42
Africa	174	77
Chile	154	42
England	129	12
Spain	48	17
Canada	49	9
Japan	39	42
Norway	39	37
Mexico	30	10
Brazil	26	16
China	25	13
Java	25	5

Wood-Block Pavements Restored by Seal Coat

Buckled and Dried Out Pavements Put Into Good Condition by Applying a Bituminous Seal Coat Covered with Sand

By James A. McElroy
City Engineer, Bridgeport, Conn.

BRIDGEPORT, CONN., has about 150,000 sq.yd. of wood-block pavement, all less than 15 years old. On some streets it is in excellent condition after ten or more years of service. On others, especially on streets that have car tracks, it is in poor condition in spite of the fact that considerable money has been spent on it every year to keep it in condition.

The blocks were originally laid on a 6-in. concrete foundation with a 1-in. sand cushion. The trouble seems to be that after a few years the blocks lose most of the oil with which they were treated. Then a few days of wet weather following a warm dry spell, will cause the blocks to expand and buckle. When they are relaid some of the old blocks are broken and new blocks are required, the cost of which makes the repair work expensive.

A few years ago I suggested to one of the wood-block companies that they might devise some method of treating old blocks on the street. The cheapest scheme they could suggest was to take up the blocks and relay them with another type of cushion. They estimated the cost at $1 to $1.25 per square yard, exclusive of the cost of new blocks.

It was then decided to seal the old wood-block pavements by giving them a surface treatment of hot road oil. Tarvia B was tried on State St., which had buckled badly during the heavy rains of last June. After the blocks had been leveled, the material was applied with sprinkling cans at the rate of 0.4 gal. per square yard. It was allowed to stand for about an hour and then covered with sand, 1 cu.yd. of sand to 100 sq.yd. of pavement. Covering with sand immediately after the application was also tried but it could not be seen that it made any difference in the final result. It was found, however, that the Tarvia B was easier to apply if it was heated. After a few days under traffic the treated blocks had the appearance of a new pavement, and although considerable wet weather has been had since the work was done, the blocks have shown no signs of buckling. This treatment cost 10c. a square yard for 5,000 sq.yd.

On Fairfield Ave. and part of State St., Texaco special macadam binder was used. The material was heated to a temperature of 250 deg. F. and applied with a pressure distributor at the rate of 0.4 gal. per square yard. It was immediately covered with sand, 1 cu.yd. of sand to 100 sq.yd. At the end of a week the sand was well worked into the asphalt, forming a thin mat which effectually sealed the block and gave it the appearance of a sheet asphalt pavement. About 13,000 sq.yd. were treated with special macadam binder at a cost of 76c. per square yard.

Director of Public Works, George M. Coughlin, is so well pleased with the results obtained that he expects to treat a number of our wood-block streets in this way next year, believing that if they are treated in time, a considerable saving in maintenance will be effected and the life of the pavement will be prolonged.

Erecting Office Building Over Complicated Track Layout

Difficulties Met in Constructing Building Independent of Railroad Structure Containing Two Track Levels

CONSTRUCTION difficulties perhaps unique in New York office-building work have been encountered in erecting the twenty-story Park-Lexington building now under construction at Park Ave. and 46th St. These difficulties were occasioned by the necessity of carrying foundations for the building to bedrock entirely independent of the steel in the New York Central R.R.'s double-deck track structure over which the building rises, and threading the supports through two track levels of different arrangement. The building covers the whole block on the eastern side of Park Ave. with a depth of 80 ft. on 46th and 47th Sts.

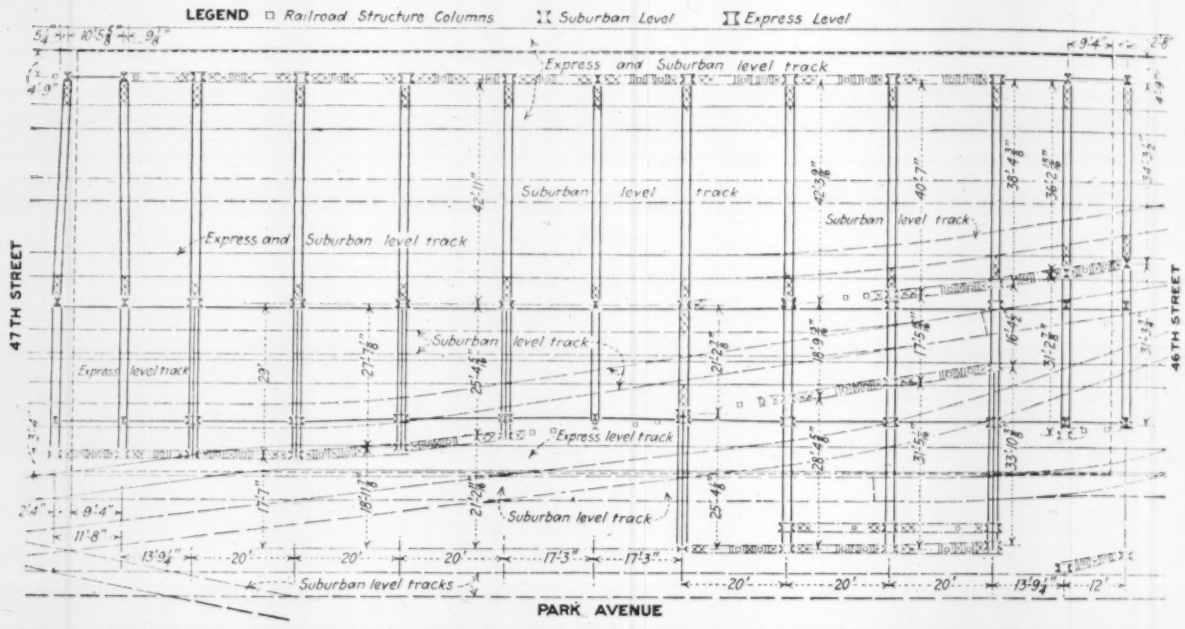


FIG. 1—LAYOUT OF TRACKS AT BOTH LEVELS, AND POSITION OF RAILROAD STRUCTURE AND BUILDING COLUMNS

The principal difficulties in the construction work were encountered in cutting through the suburban and express levels of the track in order to get foundation steel and other materials through. Extremely limited space necessitated workmen operating much of the time from staging suspended from girder flanges, as it was impossible to install a plant which in any way obstructed or interfered with the operation of trains. Inasmuch as trains run frequently, particularly during rush hours, the difficulties which the contractor met are obvious. The express-train level tracks are about 22 ft. below the Park Ave. street surface. The suburban-level tracks are about 28 ft. below the express-level tracks, making the suburban level therefore about 50 ft. below the street surface. The principal difficulties in construction were met in the suburban level.

The steel supporting the express and suburban levels of tracks had been designed originally to carry twelve-story building loads in addition to the railroad structure. After the Grand Central Terminal development had been finished, however, it was found that any building supported on railroad steel was subjected to vibration caused by trains. In the Park-Lexington building, therefore, independent steel was used throughout the foundation in order to eliminate railroad train vibration in so far as possible. This required wind struts and bracing to be placed between the new columns below the street level. Nearly 1,600 tons of structural steel were used below the Park Ave. level in this substructure foundation and no part of this steel touches the railroad structure at any place.

The building has 43 steel columns in the substructure work. These rest on steel billets from 4 in. to 7 in. thick, which are supported on independent foundations of steel grillages and concrete, in turn resting upon bedrock. The excavation for the column grillages was in general about 6 ft. below the top of the suburban level rail and it was necessary in order to secure adequate foundation area to extend most of the foundation grillages under the suburban level railroad track.

In order to minimize transmission of vibration through the rock all of the 43 columns are supported on cushions. These cushions, or vibration mats, consist of double layers of sheet lead and asbestos placed between the column bases and the foundation grillages. Laterally, a 4-in. clearance space is maintained between the building columns and the railroad steel or the concrete protection walls. This space is closed by cork.

The steel street viaduct supporting the street surface around the building is separated from the building itself at the sidewalk line by a continuous expansion joint which is open 4 in. A similar clearance is maintained around all of the building columns where they pass through the railroad express level floor. All of the steel for the building substructure is to have a 2-in. concrete fireproof covering. The minimum 4-in. clearance is maintained between the fireproofing surface and any part of the railroad structure.

Actual construction methods in carrying out the work were necessarily governed by railroad traffic conditions. In order to provide space for the new substructure columns and foundations it was necessary to cut away

large portions of the concrete and smaller portions of the steel of the original railroad structure. The concrete cutting was accomplished with pneumatic air drills which worked mostly at night. A small amount of the rock excavation for the new column footings was accomplished partly with the aid of light blasting. Compressed air for the drills was supplied from the

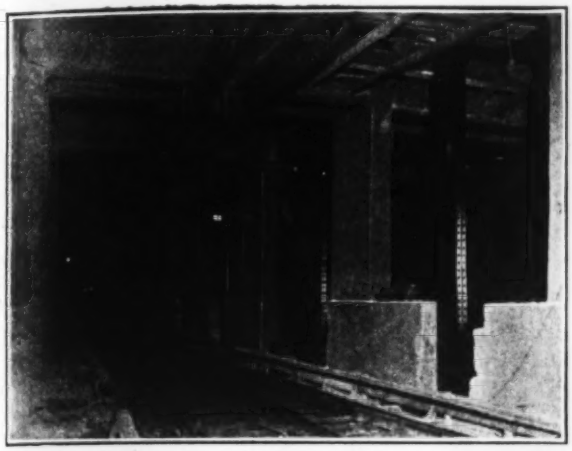


FIG. 2—NEW STEEL IN PLACE AT SUBURBAN LEVEL
Some idea of the restricted space in which workmen operated can be gained from this photograph. Concrete connecting walls first had to be cut away, then where railroad grillage steel interfered, it was burned away to give a 10-in. clearance between it and building column grillages. This steel was let down through holes cut in the concrete floor of the railroad structure.

49th St. power house of the New York Central R.R. In carrying on this portion of the work it was necessary to protect carefully the third rail used for the transmission of electric locomotive power. In general, the third rails were kept alive and protected by boards.

Another difficulty was met when concrete was poured for footings. Inasmuch as the column footings could only be poured one or two at a time, as conditions permitted, hand mixing of material at each footing was the only satisfactory method that could be employed. Concrete materials were delivered from the street surface by means of long chutes.

One of the most difficult parts of the work was met when cutting through the 30-in. steel stringers of the old railroad structure at the express level floor was begun in order to provide room for the new steel. This cutting was accomplished with oxy-acetylene torches, workmen operating from staging attached to the flanges of the heavy girders just over the suburban-level tracks. This staging was used for each of the 35 stringers that were cut as well as for concrete cutting and fireproofing and the erection and riveting of the new steel.

In the express-level track area conditions were simpler as to working space. Three passenger platforms separate four parallel tracks. However, the work was hampered by the fact that the express-level tracks do not line up above the suburban-level tracks below so that many columns could not be carried up directly from their foundations to the street surface level. It was necessary to offset 21 columns on 15 girders placed just beneath the express-level deck. This condition was the one which made it necessary to cut through the 30-in. steel stringers of the express-level deck in order to let the building columns through. Unsupported ends of the cutoff stringers were carried by header beams to the next adjoining stringers.

An interesting feature of the steel construction in the substructure work is the employment of eleven large distributing girders placed at the Park Ave. level which are carried the entire width of the twenty-story building above. Some of these distributing girders are as deep as 7 ft. and weigh 33 tons. They constitute, in effect, an elevated foundation upon which the building rests.

With the railroad using for its trains the space in the building which ordinarily would have been occupied by boilers, mechanical and electrical equipment, the owners were confronted with the necessity of supplying heat, power and light from other sources. This difficulty was overcome by obtaining all heat and electric power from the central power station of the New York Central R.R. at Park Ave. and 49th Street.

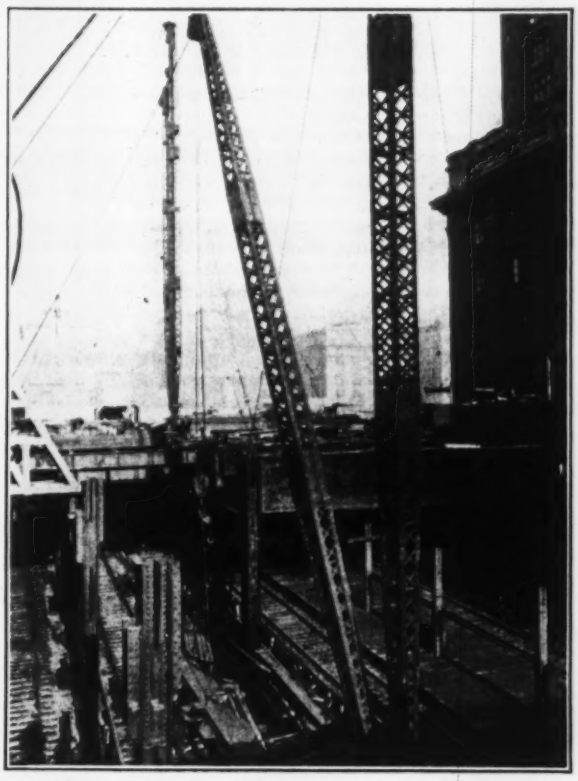


FIG. 3—ERECTING STEEL AT THE EXPRESS LEVEL
Construction was made easier at this level as steel could be handled from street to storage between tracks by derricks.

The Park-Lexington building is to be a twenty-story office building of the highest class. It will be connected by overhead bridges at the third, fourth, fifth, and sixth floor levels with the present Grand Central Palace, just east of it. These bridges, however, will be made structurally separate from both the Grand Central Palace and the Park-Lexington building by means of steel and sheet lead expansion joints.

Design of the substructure work was made by H. G. Balcom, consulting engineer, and the work carried on under the general supervision of W. J. Thornton, terminal engineer of the New York Central R.R. The Merchants and Manufacturers Exchange of New York City is the owner of the building. The construction work both for substructure and the building itself is being done by T. C. Desmond & Co., Inc., general contractors, with W. T. Spalding engineer in charge.

State Road Maintenance Through County Organizations

Advantages and Disadvantages—Patrol Organization—Mileage Costs for Five Years—Results Show Money Profit

By J. T. Donaghey
Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

Paper presented at the annual convention of the American Builders Association, Chicago, Ill., Jan. 18, 1923.

WISCONSIN has 78,000 miles of all classes of highways. At the time of taking over the maintenance in the spring of 1918, the records showed that 255 miles were concrete; 1,775 miles were stone macadam; 15,670 miles were gravel, most of which was ordinary town work, and 60,300 miles were earth. It was believed that a system containing not less than 10 per cent of the total road mileage of the state would be required to serve traffic reasonably well, and that eventually the public would demand that not less than 20 per cent of the total road mileage should be adequately maintained.

Maintenance Administration—A plan of administration was the first consideration. The question was: Should the state maintain the entire system with a state organization, the state paying the entire cost, or should the actual maintenance work be done by each county and the county be reimbursed by the state after the work was satisfactorily performed? There were many advocates of each plan. After analyzing the two the following conclusions were reached:

A—Under the state maintenance organization plan it appeared that:

1. The highway department would have closer control of the entire maintenance operations.
2. The work might be better and more economically done and in many instances done more promptly.
3. The costs of the work would be more accurately kept and unit costs of work could be shown on many specific parts of the work which would be of considerable value on other similar work in the state.

B—Offsetting these obvious merits appeared certain disadvantages which could be enumerated as follows:

1. It would require an appropriation sufficient to purchase approximately $2,000,000 worth of necessary maintenance equipment; this appropriation would have been very difficult, if not impossible, to obtain from the legislature at that time.
2. It would require an organization of experienced maintenance men that would be difficult to procure without employing the very men who were employed on road work by the several counties.
3. It would result, in many instances, in the operation of a state road-maintenance crew in close proximity to a county road crew, which would be undesirable, as the laws permit state employees to work but eight hours a day while county forces may work ten hours.
4. There would be no incentive other than the example of good maintenance shown by state work, to induce the local communities to maintain other roads not a part of the state trunk system.
5. Criticism of the work as a state organization would come from the other side of the road fence, which in many instances would not be constructive or helpful criticism.

C—If a plan of operating through the counties were adopted, it appeared that it would have these advantages:

1. The county organizations previously employed in each county to build roads could be utilized to maintain the state trunk system; that is, trained men familiar with conditions in the county would be put in charge of the maintenance work in each county.
2. The equipment owned by the counties would go a long way in providing the necessary tools and machinery for the maintenance work, removing the necessity of purchasing duplicate machinery.
3. The counties, represented by their local officials, would be actually doing the maintenance work, and the general public would not criticise them as freely as it would state officials doing such work. The highway commission's criticism of the counties' work probably would be much broader and more constructive than the counties' criticism of state work would be.
4. The fact that the local officials were actually in charge of the maintenance work would inspire them to want a larger mileage maintained locally, and through their efforts sentiment would be developed for the proper maintenance of additional roads in every community.

D—The possible defects of working through county organizations appeared to be:

1. The lack of co-operation between the county officials and the state highway department.
2. The possibility of work costing more than it should, due to lack of proper supervision.
3. The possibility that some of the work would be done in a more or less slip-shod manner.

After weighing both plans, the commission decided to operate through the counties as a unit, primarily because it believed that the *sentiment which would be created for the improvement of roads* other than those contained in the state trunk highway system would eventually more than offset the possible inefficiency and other unsatisfactory features of this plan.

Organizing For Patrol Maintenance—For convenience, the commission established nine divisions, containing approximately eight counties each. A resident engineer, called division engineer, is in charge of each, with the necessary assistants to plan and supervise the work. An assistant, known as division maintenance engineer, has charge of all maintenance, marking and signing. The latter visits each patrolman at least twice a month, reporting each visit by card to the main office. In 1922 there were 10,940 visits reported.

Each county is governed by a county board, consisting of a representative from each township and village and also one from each ward of every city. The county board elects a committee of three to represent it in all matters connected with road work, and also elects a county highway commissioner who has direct charge of all road construction and maintenance by the county. Each county highway commissioner has an assistant known as patrol-maintenance superintendent who is in charge of maintenance. He visits each patrolman at least twice each week.

The county road committee really acts as a board of directors and as a buffer between the county highway commissioner and the county board on the one hand and the state highway department and the county board on the other.

Prior to the selection of the system authorized by the legislature, the division engineers made a condition survey of all competing roads showing the actual conditions existing on every mile. After the selection of the system another survey was made, at which time the distance was measured accurately and stakes set each mile locating future mile posts. The information on each mile shows by tenths of a mile the soil, drainage, type of surface and condition. This information was very helpful, later on, in planning the patrol system in each county.

The law provided that "each county must adequately maintain the portion of the system lying within the county, according to the specifications, directions and to the satisfaction of the highway commission."

The commission determined that a thorough patrol system must be installed at the very beginning which would cover every mile on the system, whether previously improved or not. The portion of the system lying in each county was divided into patrol sections by the county committee, acting jointly with the county highway commissioner and the division engineer. The patrolman for each section was selected in the same manner. The county committee advertises in the local press that on a certain day those seeking the jobs of patrolmen for the coming season must report at the county court house. The applicants "if new" are interviewed by the county committee and the division engineer, and the most

promising candidates are given the positions. Applicants having served as patrolmen one or more seasons are given preference over new men and usually receive more salary.

Each patrolman enters into a written contract with the county and gives a bond in the amount of $500 for the faithful performance of the work and proper care of the tools and machinery entrusted to him. The contract is also subject to the approval of the division engineer.

On "team patrol sections" the patrolman must furnish a team and wagon, the county a light blade grader, road planer, plow, slip scraper and miscellaneous small tools. On "motor truck or tractor patrol sections" the county furnishes all the equipment.

The salaries paid on team patrol sections range from $140 to $165 per month for the 1922 season; those on motor truck and tractor patrols average about $110 per month. The season extends from about April 1 to Dec. 1, and from Dec. 1 to April 1 the patrolman agrees to work when requested at a fixed price per hour.

The "team patrol sections" average about 6⅔ miles each, and as a rule are confined to earth road sections and those gravel sections that carry light traffic. There are few tractor patrol sections. They average about 12 miles in length and are generally confined to earth roads but are sometimes preferable on heavy traffic gravel roads where heavy maintenance equipment is necessary. Motor truck patrol sections average about 18 miles, and are economical only on heavy traffic roads where heavy maintenance equipment is necessary and where new material must be hauled regularly, on surface treated stone or gravel, and for work on concrete surfacings. We find that on earth or gravel sections where traffic does not exceed an average of 200 vehicles per day the "team patrol" is cheap and satisfactory.

Costs on State Trunk Highways—The 1917 legislature provided for a 5,000-mile state trunk highway system, which the legislature of 1919 increased to 7,500 miles. Table I shows the actual miles maintained by patrol methods each year, the number of patrol sections, the salary paid patrolmen, the patrol maintenance cost of each type per mile, and the amount expended per mile out of maintenance funds for "betterments." "Betterments" consist of widening the road and providing drainage with heavy blade grader work, light resurfacing, new culverts, and the cost of marking and signing the system.

Counties Develop Maintenance—Several county boards as early as June, 1918, provided for patrol maintenance on important secondary roads. The growth of this sentiment is shown by Table II stating the miles of county trunk highways taken over for maintenance each year by the several county boards, the number of patrolmen employed, salary, cost of marking and signing, and total expenditures.

Table II bears out the original idea and proves that the plan of operating through the counties has resulted in local demands for more roads to be maintained each year by patrol methods and consequently a much greater mileage of patrolled roads. In addition to the 7,500-mile state trunk system, we now have a 9,880-mile county trunk system, making a total of 17,380 miles of well maintained roads. This gives more than 80 per cent of our population direct service, and brings patrolled roads within two miles of the remaining 20 per cent.

Results Obtained—The patrol maintenance plan adopted in 1918, improved upon from year to year, and extended to include additional county highways each year, has certainly served traffic better, and satisfied the public to a greater degree than the expenditure of the same amount of money each year in constructing a few lines of high type surfacing would have done. After five years of patrol maintenance we find that the following conditions prevail:

1. Every town, city or village in the state is on a well-maintained and marked highway.

2. Traffic is distributed over a large mileage, reducing congestion on many highways.

3. The average speed of traffic has been increased at least ten miles per hour, resulting in great time saving.

4. Night driving is safe and practical and our traffic census shows a marked increase each year in night traffic.

5. Prosperity immediately becomes noticeable. The farmers along such routes soon vie with each other in promoting neatness in their road fences, farm buildings and entrances. Farm names appear over the gateway and the mail boxes are given a fresh coat of paint. Letterheads even show the location of the farm by trunk highway route and mile number. Products of the farm are sold direct to the city dweller at a price satisfactory to both. In the villages and cities along the routes new inns or tea rooms, rest rooms and garages spring up to serve traffic.

6. Last, but not least, is the tourist, and our definition of a tourist is any person using our highways for pleasure, whether residents of Wisconsin or not. We realize that nature has provided Wisconsin with scenic features in abundance; nevertheless, the tourist today would not be with us if our highways did not make traveling by motor car a pleasure. As to the amount spent by tourists, from the most accurate data available we are confident that it now exceeds $100,000,000 annually. The little village of Kilbourn, located at the lower entrance to the "Dells of the Wisconsin," containing a population of but 1,200 people, furnished us accurate records kept by the banks, hotels and business houses for the 1922 season, showing that over one million dollars was left in that vicinity alone by tourists; also that a count taken by the business men's association one night registered more people camped in the village camping grounds than were living in Kilbourn. Many towns on patrolled highways provide free camping grounds.

Wisconsin is satisfied that during the five years of patrol maintenance, 1918-1922, tourists have left not less than $300,000,000. Figuring a net profit of but 20 per cent, which is very conservative, the profits from this source would be $60,000,000, or about seven times the total expended for patrol maintenance and marking and signing the state trunk system since April 1, 1918.

TABLE I—FIVE-YEAR MAINTENANCE RECORD WISCONSIN STATE ROAD SYSTEM

Year 1918	1918	1919	1920	1921	*1922
Actual miles maintained	4,998.9	4,998.9	7,234.0	7,260.4	7,458.59
No. patrol sections	561	561	791	911	940
Monthly salary team patrol	$130.00	$145.00	$165.00	$155.00	$150.00
Monthly salary motor patrol	90.00	110.00	125.00	115.00	100.00
Patrol maintenance cost per mile:					
Earth	135.21	154.01	187.24	196.21	186.40
Gravel	120.80	133.63	184.68	193.85	183.25
Stone and gravel surface treated	575.21	626.33	706.11	682.23	671.84
**Concrete	162.21	210.42	220.18	322.21	311.85
Cost patrol maintenance	573,042.16	767,302.12	1,220,535.00	1,326,927.24	1,355,900.00
Cost of betterments	396,449.65	488,529.68	756,474.38	1,028,976.04	952,850.00
Cost of marking and signing	7,888.22	17,776.16	28,820.61	20,462.14	41,250.00
Total expenditures	$977,430.93	$1,273,607.86	$2,005,829.89	$2,381,413.85	$2,350,000.00

The above total expenditures average $278 per mile per year.
* Final costs will vary somewhat from figures shown, as the season is not complete at this date (Dec. 15, 1922).
** Annual costs include all shoulder maintenance, which runs high on all surfacings less than 18 feet.

TABLE II—COUNTY TRUNK-LINE ROAD TAKEN OVER FOR MAINTENANCE YEARLY FOR FIVE YEARS

Year	1918	1919	1920	1921	1922
Miles maintained	2,021	5,590	7,743	8,980	9,885
Number of patrolmen	232	705	970	1,123	1,236
Average monthly salary of patrolmen	$125	$140	$160	$150	$145
Cost of maintenance	475,000.00	1,226,267	1,435,527	1,867,615	2,279,804
Cost of marking and signing		3,600	9,300	8,100	11,000
Total expenditures	$475,000.00	$1,229,867	$1,444,827	$1,875,715	$2,290,804

The above total expenditures average $214 per mile per year.

Concrete Structures for D., L. & W. R. R. New Grade Crossings

Different Standard Street Crossings and Elevated Station Structures Used in East Orange Grade Elevation—Old Masonry Arch Elevated by Concrete Superstructure

By M. Hirschthal
Concrete Engineer, Delaware, Lackawanna & Western R.R., Hoboken, N. J.

THE most effective "Careful Crossing Campaign" is that of grade crossing elimination, a fact recognized by the management of the Lackawanna R.R. as early as 1910 when this work was begun near its east terminal on the Montclair Branch and on the Morris & Essex Division a few years later. In turn the grade crossings were eliminated at Morristown, Chatham, Madison, Convent, South Orange, Morris Plains and Orange, so that with completion of the East Orange improvements, construction features of which were described in *Engineering News-Record*, Nov. 9, 1922, p. 778, there will have been eliminated all crossings at grade between Mount Tabor and Hoboken, removing all danger to vehicular traffic from that source in the thickly populated suburban district.

On the main line through East Orange, eleven grade crossings will be eliminated and three on the Montclair Branch, in addition to providing a new crossing at 16th St. on the main line and one at Rutledge Ave. on the branch. To accomplish this the bridge construction on the main line includes two viaducts in connection with each of the stations, six undercrossings, one pedestrian subway, the reconstruction of one overhead footbridge and the construction of a viaduct on top of the present Parkway Arch Bridge, in East Orange. On the branch four undercrossings have been constructed.

For 50-ft. streets, of which there are three on the main line and two on the branch, the type of bridge designed was one with a 2-ft. pier, having arched openings, located on the center line of the street with 24-ft. clear spans on either side and abutments on the street

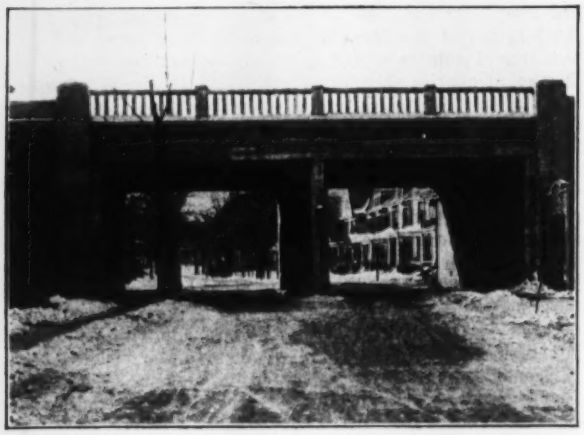


FIG. 1—TYPICAL 50-FT. STREET UNDERCROSSING

lines. A reinforced-concrete slab spans across the pier from abutment to abutment. For the 60-ft. street, that at Greenwood Ave., additional 2-ft. piers were placed at each of the curbs providing two roadway and two sidewalk spans.

The remainder of the undercrossings are for larger streets and consist of circular columns surmounted by slabs of the cantilever flat-slab type having four-way

FIG. 2—FLAT SLAB TYPE UNDERCROSSING, SIXTEENTH ST., NEWARK

reinforcement and depressed panels at the column capitals. Of this same type are the viaducts in connection with the Brick Church and East Orange stations, although at the latter it is in combination with other types.

At Brick Church the viaduct is continuous from the east street line of Halsted St. to the west street line of Harrison St., a distance of 1,080 ft. Originally the plans called for bridges of seven spans each at Harrison and Halsted Sts., open construction at the station and retaining walls and fill between these points. The enhancement in the appearance of the construction and availability of the open space for future use finally overcame the obstacle of somewhat increased first cost so that the open construction was adopted throughout.

The first designs contemplated the use of the fascia column type for both the Brick Church and East Orange Viaducts but due to the conditions at the former which involved some very expensive property if this type were adopted, the cantilever type was designed to permit of the extension of the driveways under the viaduct, obviating the necessity of the purchase or reconstruction of a modern and expensive warehouse building. This revision materially changed the character of the Brick Church as compared with the East Orange viaduct, in its structural and architectural design and even in the station facilities.

Structurally the two cantilevers on the Brick Church structures displace one span of that at East Orange, resulting in a complete difference in the reinforcement of both columns and slab in the two structures. Architecturally, we have the continuous unbroken cantilever fascia at Brick Church surmounted by an iron railing in contrast with the pilasters at each bent of the East Orange viaduct, fascia arches sprung between them and an open concrete balustrade above.

The headhouse of a station connecting with a cantilever structure would of necessity be of a character different from that of one with fascia columns and here at Brick Church in addition, it was necessary to provide additional driveway space, hence a one way thoroughfare through the headhouse. All in all the final designs produced structures at each of the stations absolutely dissimilar in practically all features, except track and platform facilities. The comparative designs as governed by the varying conditions at Brick Church and East Orange, are the subject of an article to appear in an early issue.

Parkway Viaduct—The most unusual structure of any on this improvement is that at East Orange Parkway. Prior to the track elevation now in progress the tracks over the Parkway were supported on three segmental masonry arches, the center one of which is 40-ft. clear span, while the ones on either side have

FIG. 3—FLAT SLAB TYPE, SPRINGFIELD AVE., MONTCLAIR

concentrations on the present arch rings and yet be of sufficiently light construction not to increase unduly the loads on the piers and abutments.

The first alternative was abandoned because of, first,

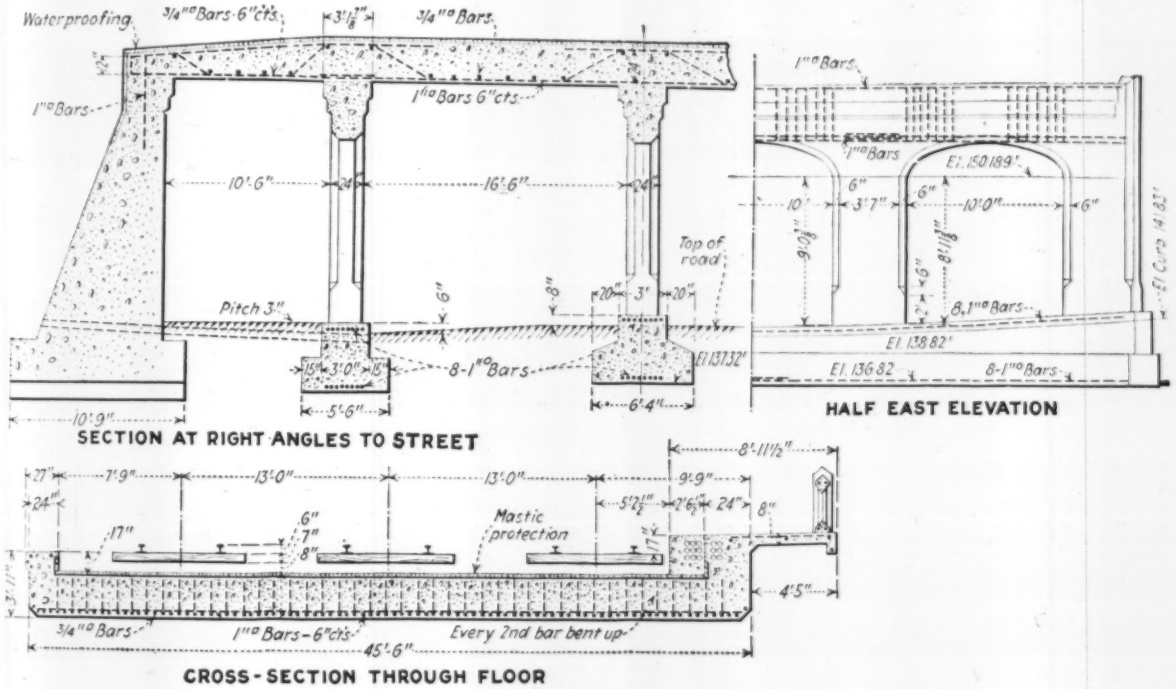


FIG. 4—SECTIONS THROUGH 60-FT. STREET UNDERCROSSING, GREENWOOD AVE.

spans of 20 ft. with 10-ft. piers between. The track was carried on an earth fill retained by masonry spandrel walls. The width was sufficient to accommodate three tracks although only two were then in operation. The new line is elevated at this point about 11 ft. above the old, and there were three solutions presented to the problem of accomplishing this elevation. First, was the construction of solid walls at the two faces with fill between up to the subgrade of the new tracks. An analysis of the present arches and piers disclosed the fact that this condition would dangerously increase the stresses in the arch ring and the maximum foundation pressures to the point of making the structure unstable; therefore this scheme was eliminated from consideration.

There then remained the alternate schemes either of entirely demolishing the present structure and building one entirely new or of designing an open structure on top of the present one which would not result in any excessive expense of the new construction, second, the difficulty and cost of removing the present construction and, third, lack of space for temporary train operation and new construction.

The question then resolved itself into what would be the type of open construction best adapted to the conditions involved. The present design is the result. For the main spans reinforced-concrete T-beams were designed 6 ft. 6 in. apart on centers, that is two beams per track; they are reinforced by three rows of steel, the bars in the top row being bent up to resist diagonal tension, for which purpose stirrups were also provided. These beams are supported by piers of the same thickness as that of the stem of the beams (2 ft. 6 in.), and of a width equal to the 10-ft. width of the arch pier below and are tied together by a 2-ft. thickness of cross wall at the outer ends of the piers. This wall acts also as a support for the two-way slab of the adjacent span

which was made 22 ft. 11 in. clear longitudinally, so as to extend somewhat beyond the face of the abutment and resulted in panels sufficiently close to square to permit of their design as a two-way slab reducing its thickness, and hence the load on the present structure. For the same reason open spans were designed over the abutment, resulting in three two-way panels over each abutment. The slabs of these panels are supported by two longitudinal girders and the fascias, while transversely girders and columns were designed rather than

to be constructed so as to accommodate two tracks, it being planned to build the other section, after the two tracks are in operation on the new work. The construction joints are shown on the general plan.

The structures on both the main line and the Montclair Branch were designed under the direction of the writer, the Main St. portion under that of A. E. Deal, bridge engineer, and the stations under that of F. J. Nies, architect. O. H. Kellogg is the resident engineer in charge of construction, and M. H. Doughty is the

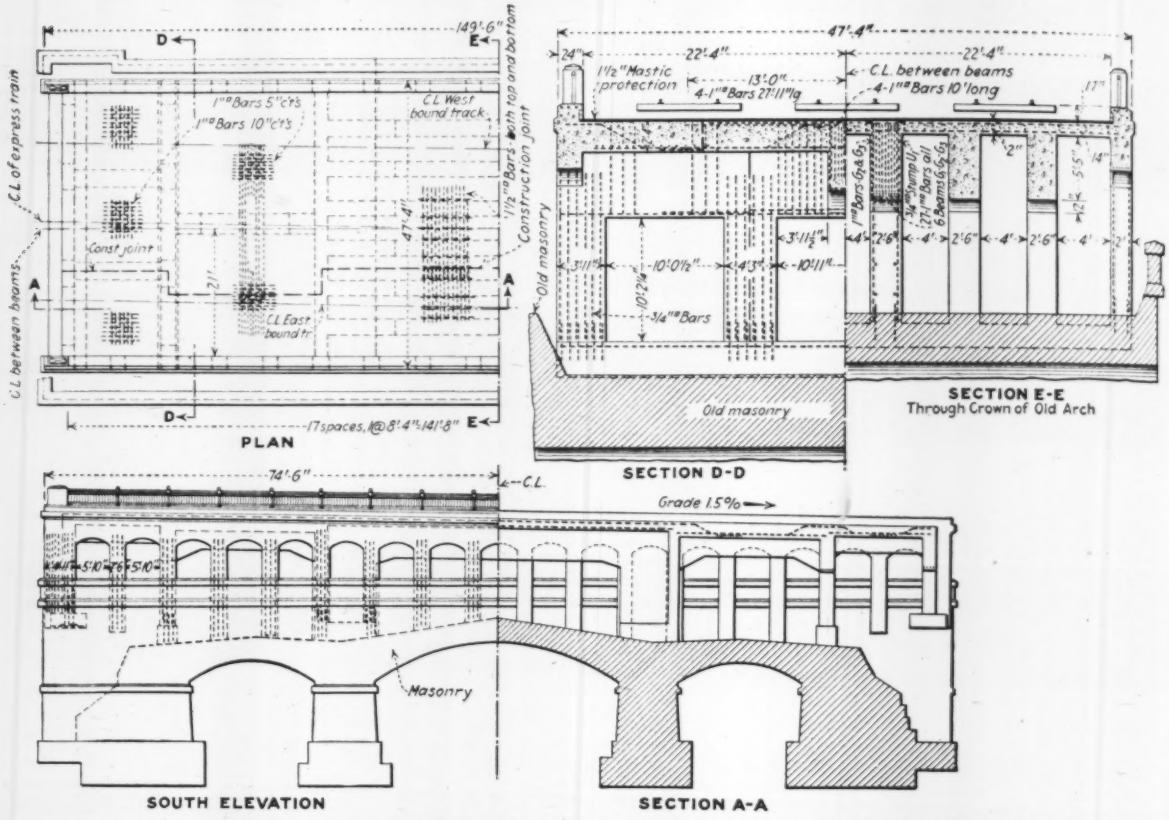


FIG. 5—DETAILS OF NEW CONCRETE TRACK ELEVATION OVER OLD MASONRY ARCH, AT PARKWAY, EAST ORANGE

solid walls, the fill being partly retained by the end girders, the remainder flowing through underneath them.

All the piers are carried on continuous concrete footings on the old masonry, the earth fill being removed to permit their construction. For architectural effect, so as to produce a structure somewhat in keeping with the present construction the fascia girders were broken up into a series of arches extending from end to end of the structure, of such span and pier width as to be uniform and symmetrical throughout. In addition the piers above the line of the present parapet were scored as were also the arch rings with the effect illustrated in the view. The railing is a combination of structural steel and pipe railing. The result was the design of a structure which added but little additional load to that already carried by the existing structure with a pleasing effect and economical in cost. The F. M. Talbot Co. are the contractors who are constructing this bridge.

While the East Orange and Brick Church Viaducts were built completely clear of traffic, the Parkway Bridge because of lack of temporary track space had

division engineer, while both design and construction are under the supervision of G. J. Ray, chief engineer.

Design and Construction of Cahokia Station

In connection with the description of foundation work at the Cahokia power station, in our issue of Feb. 1, pp. 219-221, the designers give the further information that the reason for designing the station on a unit plan was that subsequent sections might take advantage of developments in the art. The site of the plant, it should also be said, is almost opposite the center of the city St. Louis. Work being done by subcontractors includes the foundation concrete work (exclusive of piles), which is being done by the Fruin-Colnon Co., of St. Louis; the levee work to El. + 40, which is being done by the Northern Dredge & Dock Co., of Minneapolis, and the foundation pile work, which is being done by the Raymond Concrete Pile Co., of New York. The general construction work, as well as engineering, design, and purchase of materials and equipment, is being done by McClellan & Junkersfeld, Inc.

American Railway Engineering Association Meeting

Increase in Committee Work and Large Attendance—Progress in Rails—Highway Bridge Specifications Presented—Passenger Station Design Under Study—Relation of Association to Standards Committee

AT THE twenty-fourth annual meeting of the American Railway Engineering Association, held at Chicago last week, the growth of committee work as the major activity of the association was apparent not only in the volume and broad scope of the reports presented but also in the reduced amount of open discussion. The meeting was unusually active, in spite of a somewhat lower attendance than that of last year's meeting, and plainly reflected the renewed activity in railway development. Because of the sparse discussion the following condensed review of the meeting is limited largely to an outline of the points of engineering interest in the committee reports.

Co-operation with Standards Committee—Close co-operation between the association and the American Engineering Standards Committee was recommended in the report of the committee on Standardization. At present the association is a member of the A.E.S.C. only indirectly, through the American Railway Association, although it has presented to the A.E.S.C. for adoption as American Standards two of its specifications, those for fixed and movable railway bridges. Discussion of the report dealt with the question of whether the association should become a member of the A.E.S.C.

A. W. Whitney, chairman of the latter body, and J. A. Capp, vice-chairman, addressed the meeting, giving reasons why the association should join. Mr. Whitney urged that the A.R.E.A. is not a sufficiently large interest to work by itself, out of contact with other interests. Mr. Capp argued that railroad men need the broadening effect of discussing their problems with other groups of men having related problems. On the other hand C. A. Morse (Rock Island Lines) expressed the view that the association has enough to do in getting the railways together in using the association's standards, and is little concerned with having these standards approved by outside interests. He held, also, that the problems of electric railways and of industrial trackage are distinct from those which are before the association. E. B. Katte (New York Central) said that the association's committee on electricity had recently been outvoted in a national standardizing body and a specification adopted that is less strict than the railway interest requires. To show that the work of the A.E.S.C. is too complex and too slow for the association's needs, he cited the delay of more than two years in formulating insulated wire specifications. The association would find itself in an unsatisfactory condition if it had not prepared its own specification. He favored continuing present representation on the A.E.S.C. by one member.

O. F. Dalstrom (Chicago & Northwestern) made the point that the association must be represented in the A.E.S.C. in order to defend its own interests and prevent the adoption of standards not acceptable to it. He instanced the fact that two railway bridge specifications are now in the field, and that it is essential for the association to submit its own specifications to the A.E.S.C. for adoption, as it has done. E. A. Frink (Seaboard Air Line) argued that standardization by a single industry, such as the railways, can never equal that done by a national body such as the A.E.S.C.

No action was taken by the meeting. However, R. H. Aishton, representing the executives as president of the American Railway Association, spoke at some length, expressing the opinion that the American Railway Engineering Association should decide how much representation of railway interests on the American Engineering Standards Committee is necessary, and that the A.R.A. would probably support their decision. Referring to the important fact brought out in the prior discussion, that the standards collected in the association's "Manual" are far from being in universal use by railways, he urged that the association make it its first object to bring about the use of its own standards.

Rail Failures and Quality—Statistics of rail failures, presented by the Rail committee as in previous years, continue to reveal a deterioration of quality of rail in the 1916 and 1917 rollings. The number of failures per 100 track-miles during five years' service ranged above 200 for the rails rolled about 1910, while subsequent improvement of quality brought the failures of 1914 rail down to 74. The latter figure increased to 105 for 1916 rail. Preliminary service indications for the rollings of 1918 and subsequent years indicate renewed improvement.

New methods of reporting rail failures led to some active discussion. A new form on which failure reports are to be entered by the section foremen was first adopted, then rejected, but finally, on a second reconsideration, was approved; changes in the form to suit the needs of the foremen are to be made.

Experience with the new non-segregating rail steel specification brought out a year ago for experimental use was reported, as reproduced in brief abstract. The rail so far rolled under the specification shows on the average a higher ductility than earlier rail, by one or two per cent. Whether the results in the track will also show greater toughness is not yet known, but the committee recommended that a much larger tonnage of orders under the new specification should be placed by the railways, in order to give fuller service data.

Work in hand by the committee includes the study of whether longer rails (39 ft length has been considered) are desirable, collection of data on rail wear, and study of canting the rails inward. Six railways have fixed on inclinations of 1:44 to 1:20 for canted rail, the latter figure being used by four of the six.

New specifications for heat-treated track bolts and for spring nutlocks were adopted.

Highway Crossings—Some sharp discussion developed in connection with a report on highway crossings by the committee on Signs, Fences and Crossings. The committee recommended certain grades of the roadway surface at the crossing, and suggested that diagonal crossings should be converted into square crossings by introducing reverse curves into the road alignment on either side of the railway line (see p. 543.). Criticism was directed against this proposed plan of road relocation on the ground of introducing too much curvature and making the crossing more dangerous to road traffic than before the change. Hunter McDonald (Nashville, Chattanooga & St. Louis Ry.) and others

strongly upheld the demand that the crossing should preferably be built so as to compel road traffic to slow up. G. A. Mountain (Canadian Railway Commission) said that many crossings in Canada have been relocated substantially as the plan shows. It was proposed to change the plan so as to place all the curvature on one side of the railway line, but this, as well as a proposal to eliminate the relocation sketch, was defeated, and the committee's report with sketch was approved.

Reports on bituminous and concrete crossings as substitutes for plank crossings indicate that it is necessary to place the track in first-class shape before laying the crossing pavement, or defects may develop.

Iron and Steel Structures—Specifications for the erection of railway bridges and for the design of highway bridges were presented. The former, being in final form, were adopted for the association's "Manual," while the highway bridge specifications will be merely tentative for the coming year. A set of rules for classifying bridges and locomotives as to the capacity of structures was also presented, as a tentative draft. These rules define the manner in which Cooper's system of loading is to be applied as reference standard.

Like the 1920 railway bridge specifications of the association, the highway bridge specifications are limited to fixed bridges less than 300 ft. in span. They are based on the purpose of providing structures suitable for "any traffic reasonably to be expected on highways of the different classes" and of a character equal to that of railway bridges in unit stresses, details, materials and workmanship. Three classes of road traffic are contemplated, with governing loading as follows: Primary highways, three 20-ton trucks followed by a uniform load of 800 lb. per lin. ft. for each line of traffic and 80 lb. per square foot on sidewalks; secondary highways, three 15-ton trucks, 600 lb., and 60 lb., with the alternative of a single 20-ton truck; country roads, three 10-ton trucks, 600 lb. and 60 lb., with the alternative of a single 15-ton truck. Impact is to be added to live-load stresses, based on loaded length and number of lines of traffic, with a maximum of 80 per cent on floor and 67 per cent on trusses for plank deck, 40 per cent on floor and 33 per cent on trusses for paved deck, and 20 per cent on floor and 17 per cent on trusses for street railway cars. The basic unit stress for which the members are to be designed is 16,000 lb. per square inch in tension, and 12,500 maximum in column compression.

Some minor amendments to the 1920 railway bridge specification were proposed and adopted.

Revision of I. C. C. Accounts—Supplementing an elaborate detail report including among other items a sheet of symbols for architectural drawings, the committee on Records and Accounts brought up the subject of revision of the Interstate Commerce Commission's schedule of accounts for railways. These accounts are now so badly arranged, as several speakers emphasized, that it is impossible to determine, for instance, the cost of any one item of maintenance-of-way. Revision of the schedule by the commission is already in progress, but unless engineering representatives take part in the work the new schedule may be just as worthless for engineering and operating use as the old.

Further, as was brought out by E. H. Lee (Chicago & Western Indiana) the data established by the standard accounts determine the net return which railways will be permitted to receive, under the law, and if the accounts fail to show the true cost the return (in rates) may not be commensurate to the cost. It was therefore urged, especially by E. F. Wendt (consulting engineer), that immediate action be taken by the association, in connection with the American Railway Association, to bring the engineering requirements of an accounts schedule to the attention of the commission. Up to the present only the organization of the railway accounting officers has been consulted in the revision, but this organization is not adequate to represent the engineering department. The outcome of extended discussion of the difficulty was a vote in favor of prompt action by the two associations mentioned, for participation in the revision by a committee of engineers.

Track and Track Work—Apart from the subjects of rails and track stresses, noted already, an important matter was an outline of the requirements for substitute ties, submitted by the committee on Ties. Although there is no prospect of immediate use of substitutes for wood ties the committee considers that now is the time for the railways to make extensive tests of such substitutes and to make close observations of the results with a view to further development. Treatment of white oak ties and the adzing and boring of ties before treatment were recommendations of the committee on Wood Preservation, which suggested holes $\frac{1}{16}$-in. and $\frac{1}{8}$-in. smaller in diameter than the size of the spike for hardwood and soft-wood ties respectively.

A new cross-section for gravel ballast was presented by the committee on Ballast and this was adopted after brief discussion as to its increased width of roadbed: 25 ft. 8 in. for single track and 38 ft. 8 in. for double track, exclusive of ditches. Greater uniformity in methods of measuring the size of stone for ballast was also recommended. Chemical killing of weeds has given results which justify the practice, according to the committee on Roadway, even though certain grasses are not affected. Detailed specifications for contract work in tracklaying and maintenance were submitted by the committee on Track, which also presented plans for certain switch and frog construction. Both specifications and plans were adopted for the "Manual."

Practice in bending rails for curves varies so widely that the committee considers it a matter of opinion as to whether the results justify the expense. Curve guard rails are considered desirable only for protection on extremely sharp curves. The oiling of track parts to prevent corrosion is increasing; details were given of the methods employed on several roads. Various labor-saving machines and tools for use in track work were submitted by the committee on Rules and Organization in connection with the organization of labor forces. Modified specifications for concrete fence posts of round and square section, submitted by the committee on Signs, Fences and Crossings, were adopted. A U-shaped section of post was also considered favorably.

Costs, Records and Accounts—Deferred construction costs chargeable to tracklaying and surfacing are being studied by the committee on Roadway, which expects to show a definite relation between normal cost of track maintenance and the abnormal cost during the early period of operation of a new line. Records of cost of tamping ballast by hand and machine were submitted by the committee on Ballast. Graphic methods of reporting engineering data by charts and diagrams, to supplement tabulations which afford no prospective or mental pic-

ture, were discussed by the committee on Records and Accounts. Confusion in the distribution of items in accounts occurs frequently owing to different terms being applied to the same item. In order to effect greater uniformity of nomenclature among foremen in the field and accountants in the office the committee on Rules and Organization presented an explanation of the work orders known as "authority for expenditure" (A.F.E.) and "additions and betterments." In regard to the general contract form being drafted by a joint conference, the committee on Uniform General Contract Forms questioned whether such a form in itself or a form including an arbitration clause will be acceptable to the Association.

Passenger and Freight Station Design—A comprehensive study of the principles affecting the design of passenger stations for main-line traffic was a notable feature of the report of the committee on Yards and Terminals. Its purpose is to develop the proper relations between the amount of business handled and the size and arrangement of such facilities as tracks and platforms, waiting rooms, dining and toilet rooms, ticket offices, cab service and various facilities and concessions.

Study is being made also as to: (1) economic width and arrangement of freight-house platforms, and (2) the cost of various elements of freight handling in one-level and two-level freighthouses. Design of multiple-story freight stations with warehouse floors was discussed also by the committee on Buildings, which suggested the consideration of a type of freight terminal having tracks on two levels. Systems of numbering buildings for record purposes were reviewed. Except for a slight objection to the former committee's recommendation of long tracks and high platforms in large passenger stations both reports were accepted without discussion. Specifications for tile and other building material were also adopted, these being presented by the latter committee as part of a comprehensive set of building specifications.

Plans for single- and multiple-story pile and framed trestles with open and ballasted decks were submitted by the committees on Wooden Bridges and Trestles, as modifications of previous designs. All of these were adopted for the "Manual." The committee also discussed the question of shear in timber stringers and submitted a progress report on the recommendation of specific grades of timber for specific railway purposes. Culverts of corrugated metal were accorded an unfavorable opinion by the committee on Roadway.

Deterioration of concrete structures and developments in the art of making concrete were two subjects of the report of the committee on Masonry, the matter being submitted as information and without conclusions. In regard to the committee's suggestion that alkali may affect concrete either by seepage water or by direct contact with the ground, G. A. Mountain (Canadian Government Railway Commission) referred to troubles in northwest Canada which indicate direct ground contact as the cause.

Ashpits were the only subject of a brief report by the committee on Shops and Engine Terminals. The report covered capacity, track layouts and ash-handling methods, but made no recommendations. It was adopted as a substitute for matter already included in the "Manual."

Relative merits of cast iron, steel, wood and other materials for pipe lines were discussed in the report of the committee on Water Service, with the conclusion that cast-iron is most satisfactory for underground water service under all conditions, wood-stave pipe is satisfactory where conditions are suitable and "genuine wrought iron" pipe for lines above ground. Standardization of methods of water analysis and the use of oil-engine pumps were also included, together with specifications for contract work on wells, pipe lines, tanks and machinery.

Economic Subjects—How to obtain and retain labor and how to organize labor for efficient and economical work are two important problems now facing the railroad engineer, according to the report of the committee on Economics of Labor. Similar views were presented in the address of the president. In discussion of this report, W. Beahan (New York Central R.R.) pointed out that colored labor is plentiful and may be introduced into sections where hitherto it has not been used. But this class of labor requires special handling by men who understand it and its peculiarities. Men of some kind are needed for railway work and it is up to the engineer to develop and make effective use of such labor as is available. This committee is considering methods of organizing forces for maintenance work and as a preliminary it submitted studies outlining in detail the methods of renewing rails and ties.

Three subjects relating to both engineering and transportation were dealt with at considerable length by the committee on Economics of Railway Operation: (1) Determining the effect of double-tracking on train operation; (2) calculating the cost of moving freight traffic, to show the cost of handling various commodities between certain points or to compare operating costs on different divisions or lines; (3) determining allowances for maintenance-of-way expenses due to increased use and increased investment.

Preservative treatment of piles and timbers was discussed by the committee on Wood Preservation, which advocated perforating or incising the surface of Douglas fir, since this practice gives better and more uniform penetration, aids seasoning and tends to prevent checking. Creosote, zinc-chloride and mixtures of these materials have been used successfully with Douglas fir. The report suggests a mixture of creosote and petroleum oil as permitting the injection of a larger volume of preservative without material increase in cost.

Information as to the elaborate current investigation of marine piling in waters infested by wood borers was supplemented by particulars of different methods of protecting the piles and by specifications for the preparation, treatment and handling of creosoted yellow pine piles. Returns received by the committee as to the life of creosoted timber in structures indicate 15 to 25 years in open-deck bridges, 15 to 30 years in ballasted-deck bridges and 15 to 40 years in docks and wharves.

Revised specifications for crossings of electric wires over railways, submitted by the committee on Electricity, were adopted. It was announced also that on account of the activity of various state public service commissions in regard to such specifications the Board of Direction in 1922 authorized the appointment of members in each state as local representatives of this committee. A brief statement on water power contained the recommendation of a report on the utilization of water power for electric operation of railways, with special reference to the St. Lawrence River development.

Developments in the Railway Engineering Field

Abstracts of Eight Committee Reports Presented to the American Railway Engineering Association at Its Annual Convention in Chicago, March 13-15

Metal and Concrete Ties

Committee on **Ties**

EXTENSIVE tests of substitute ties, as possible replacement for the usual wood ties, are desirable, notwithstanding the improbability of immediate general use. Only by such means and gradual development can a satisfactory substitute be produced. The larger railways should make extensive tests of one or more kinds of ties, the engineering departments following up the tests with a view to developing defects and determining improvements. It is believed that some substitute ties not suitable for high-speed main tracks may be found economical in side tracks, thereby conserving the timber supply for main-track use. Further, some ties, on account of hign first cost, can be used economically only in heavy service tracks. Some of the fundamental considerations in the design of substitute ties are as follows:

The substitute tie must have sufficient strength to prevent failure and sufficient bearing surface to support the loads and provide against undue deflection in the rail. It should be designed to resist the forces tending to disturb gage, surface and line and to permit restoration. Rail fastenings must be of sufficient strength to maintain gage, and so designed as to permit a reasonable change of width or thickness of the base of rail, or variation of gage without change in the tie and without taking the tie from the track. The fastenings should be such as to offer as little obstruction to derailed wheels as possible. They should permit shimming, the change of defective rail, or the renewal of rails, and should be replaceable without disturbing the tie. If the design provides a separate support under each rail, united by a transverse member, this member must be sufficient to maintain gage and plane and to withstand a reasonable amount of damage incident to derailment. The tie should be of such shape that it will not only resist the tendency of track to get out of line, but also permit the track to be thrown back to line. Projections on the base that project into the ballast and make it necessary to lift the track out of surface before relining are therefore objectionable. Ties clamped in pairs which enclose such an amount of ballast that the ballast must be removed before the track is lined, add a material burden to the labor necessary for lining.

The tie should have sufficient length and breadth to provide a bearing surface per rail length of track at least equal to that obtained with wood ties for the same class of track, without reducing the space between the ties to such an extent as to make tamping difficult. It should have sufficient stiffness as a beam to develop the full bearing area on the roadbed.

Where electric insulation is to be provided, the design should permit of insulation without material change in the tie proper. The fastenings must be such that the insulation material will not be subjected to abrasion or to great stress other than compression. The annual cost per unit of length of track for renewals and track maintenance should compare favorably with that of wood ties. Economy in renewals depends upon first cost and durability. Economy in maintenance will depend upon how closely the requirements specified are met.

Experience indicates that some of the features productive of failure in substitute ties are as follows: (1) Lack of efficient protection against corrosion; (2) failure of rail fastenings; (3) failure of insulation; (4) loss of beam strength due to weakening tie in vicinity of rail to accommodate rail fastening features; (5) sharp interior angles or square holes from which cracks are developed; (6) lack of resistance to derailed wheels; (7) base of tie such as to render tamping difficult or impossible and maintenance of proper surface of track impracticable; (8) tie not holding track to line, and making lining of track impracticable; (9) lack of beam strength causing breakage or yielding roadbed; (10) lack of protection in concrete ties from abrasion by ballast; (11) lack of provision for expansion and contraction in combination ties of steel and concrete.

* * *

Ballast and Machine Tamping

Committee on Ballast

AN INVESTIGATION made by the committee on Ballast as to sizes of stone ballast, indicates that the Association's standard range of ¾ to 2½ in. is used extensively, but other sizes range in minimum from ¼ to 1½ in. and in maximum from 1½ to 3 in. Greater uniformity in measuring the size is needed, since some specfications mention a ring through which the stone is to pass in any position, while others specify the sizes of holes in screens. Cost data of track surfacing done by machine and by hand, as given in the report, are summarized in the accompanying table.

COST OF SURFACING TRACK BY MACHINE AND HAND TAMPING

Hand or Machine	Kind of Ballast	Cost Per Foot of Track, Cents	Cost Per Mile of Track, Dollars	Feet Per Man Per Hour
Pneumatic	Stone	6.7 to 8.56	420 to 559	4 to 6.7 and 1
Pneumatic	Gravel	.....	502	5 6
Pneumatic	Sand	3.61	.....	.....
Electric	Stone	.....	367	4 9
Hand; picks	Stone	8.3 to 11	625 to 650	2 5
Hand; bars	Gravel	.....	500	4 85
Hand; bars	Sand	4.2	.....	.....

* * *

Curve Rails and Guard Rails

Committee on Track

RETURNS from more than a hundred railroads indicate that the practice of precurving rails differs widely in the same section of country, even where the physical and operating conditions of roads are much the same. Therefore it seems to be a matter of opinion as to whether the results obtained in precurving rail justifies the expense. Further study is to be given to the ultimate economy of this practice and its effect on stresses in the rail.

The general use of guard rails for protecting curves is not recommended, but guard rails for protecting extremely sharp curves in special locations are desirable, especially on heavy grades where superelevation is a compromise between requirements of passenger and freight service, or where there is no superelevation. Their principal function is to prevent derailments.

Local conditions will govern as to whether the advantages of guard rails outweigh the disadvantages on added cost of track structure and maintenance. Allowable speeds should not be increased on curves because guard rails are installed.

* * *

Treating White-Oak Ties

Comm ttee on Wood Preservation

IT IS recommended that all so-called "sap" ties of the species usually included under the term "white oaks" should be given a preservative treatment in order to obtain economy from their use. The so-called "heart" ties of the species usually included under the term "white oaks" can be treated efficiently so that they should withstand decay in a manner similar to other treated ties, if proper precautions are taken. A decision to treat such ties should be made only after a study on each particular line and in each particular locality has shown that treatment will result in economy.

Experience with New Rail Specifications

Committee on Rail

LAST year the rail committee presented a new rail specification for experimental use, and the rail manufacturers' association agreed to roll rail under it for trial purposes. The specification was framed with a view to obtaining quiet-setting, non-segregating steel; it provides for a minimum silicon content of 0.20 per cent in the finished steel. About 75,000 tons of such rail have been rolled, representing some 800 heats. The committee now reports that increased ductility of the rail-head metal resulted.

"The extent to which the steel is oxidized when poured into the ingot molds is probably the most important variable in general mill practice. Many believe that excessive segregation in the upper central part of the ingot, with consequent brittleness in the center of the rail head, can be largely restrained by such mill practice and specified analysis as will insure the quiet setting of the steel in the ingot molds.

"The association has undertaken to test this conclusion by authorizing circulation of the so-called 'Specifications for Experimental Lots of Dead-Setting Open-Hearth Carbon Steel Rails,' and has requested the railways to secure a substantial amount rolled to its provisions. So far only four such rollings have been made and as yet the quantity is too small to warrant general conclusions. The results of test appear to show an increased toughness in the rail head. The committee expresses keen interest in the showing and urges the Association membership to co-operate in securing a sufficient tonnage this year so that ample data may be available."

All the rail tested showed higher ductility than required under the association's 1915 specification, and all but one lot met the more severe requirement of the 1920 specification, which had been considered prohibitively high. Segregation appears to be reduced by one-half, and ductility increased several per cent, while on the other hand there is somewhat greater evidence of pipe lamination at the top of the upper rail, shown best by a nick-and-break test.

* * *

Care of Railway Work Equipment

Committee on Rules and Organization

THE ORGANIZATION for handling and care of the work equipment of a railroad should have at its head a supervisor of work equipment, reporting to the chief engineer or the chief engineer of maintenance according to the railroad's organization. He would have charge of all hoists, locomotive cranes, steam shovels, ditchers, spreaders, rail laying cranes, tie-tamping machines, motor cars, etc. The distribution of the machines for the season would be arranged by the supervisor of work equipment in conference with the chief engineer or whatever officer decides for the whole system the season's expenditures.

* * *

Corrugated Metal Culverts

Committee on Roadway

IT SEEMS to be the general opinion of railroad engineers who have used corrugated metal culverts that they are not satisfactory and that their use in general railway work should be discouraged. But it is hard to secure definite information as to failure of these pipes. To secure any reasonable service from these culverts the material must be high grade metal as nearly pure as possible and with rust-resisting properties. The galvanizing alone is not sufficient to protect the metal from rust. Reports also show the desirability of using sheets of proper gage and that a much heavier sheet must be used in the pipes of larger diameter. The best results seem to be secured when the top of pipe is placed not less than 3 ft. or more than 10 ft. below subgrade. Pipes should not be used in sizes with a diameter in excess of 48 in.

Some good results have been secured with the corrugated culverts under highway approaches at road crossings, where their cost is much less than cast-iron or concrete pipe, and in some cases less than vitrified bell-end pipe. Some satisfactory results are also reported where the pipes have been used in construction work, where cost of hauling cast-iron or concrete pipe to the job is excessive, the corrugated pipe being later renewed with the concrete or cast iron pipe after track is laid to the site.

* * *

Plan and Construction of Highway Crossings

Committee on Signs, Fences and Crossings

(Specifications approved as Recommended Practice)

1. A railroad grade crossing should be so constructed that it will not limit the traffic on a highway, in respect to the number of vehicles or load carried by the highway.

2. The grade of the surface of the highway should be level with the top of the near rail for a distance of 1 ft. outside thereof; should be 3 in. lower 10 ft. outside of the rail; and should be not more than 3 in. higher nor 9 in. lower than the top of the rail at points 30 ft. from it, measured at right angles thereto. The grade beyond these 30-ft. points

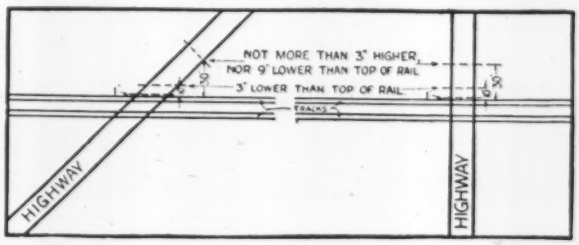


FIG. 1—APPROACH GRADES FOR HIGHWAY CROSSINGS

should not exceed that which prevails in the section of the country, for highways of the class under consideration (Fig. 1).

3. When a highway crosses a railroad at an angle less than a right angle, consideration should be given to changing the alignment of the highway, so that the portion within the limits of the railroad right-of-way would be at right angles to the track (Fig. 2).

4. The width of embankments at the crown, and of cuts exclusive of ditches, should be not less than 20 ft.

5. Ample drainage for track and highway should be provided.

6. A crossing should be constructed with continuous surface between points not less than 8 in. outside of each rail. The surface should be not more than ¼-in. below the top of

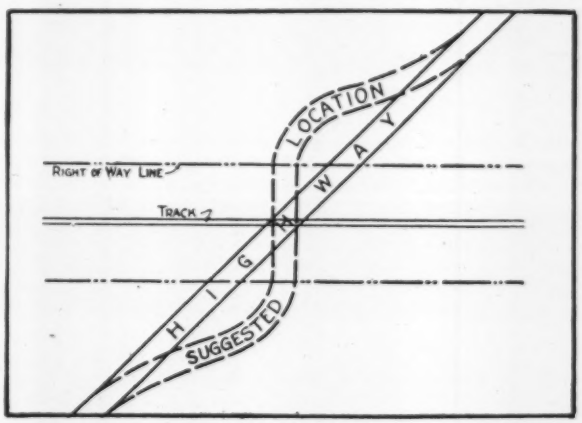


FIG. 2—RELOCATING A DIAGONAL HIGHWAY CROSSING

the rail and should be beveled at each end. Flangeways 2¼ in. wide should be provided on straight track and on curves of 8 degrees and under, and 2½ in. wide on curves in excess of 8 degrees. They should be flared at the ends to 3¼ in. There should be no rail joints within the crossing

Stresses in Timber

Committee on Wooden Bridges and Trestles

IN COMPUTING the horizontal shear in timber stringers for railway trestles the opinion has been given by J. A. Newlin, of the Forest Products Laboratory, that it would be safe to ignore all wheel loads between the quarter-points of the span and its supports. The committee's study of existing trestles seems to confirm this view, that the inclusion of all wheel loads in figuring horizontal shear is too severe in estimating the stress put on the timber.

To find some means for expressing the phenomenon that as a load approached the point of support in a beam it might be increased without apparent greater probability of failure from horizontal shear, the problem of the unchecked beam was studied from the theoretical side and two solutions were advanced for verification. But Mr. Newlin expressed the opinion that the presence of checks and defects was of such great influence on the useful strength of the timber that formulas deduced upon the assumption of unchecked timber would be of little service. Useful results could be obtained only by making a series of tests for the purpose of determining an empirical formula to express the loss of strength due to the presence of checks of measurable length and position. A search of literature on timber mechanics has shown scant treatment of the problem of horizontal shear in wooden beams.

* * *

Combination Freighthouses and Warehouses

Committee on Buildings

MULTIPLE-LEVEL freighthouses and warehouses, such as are in successful operation in a number of cities, represent a development which has marked advantages, particularly in large cities where property values are high and adequate space for terminal expansion is not available. The increasing tendency toward separation of grades of railway tracks and city streets is a condition very favorable to the construction of a multiple-story freighthouse, with such additional floors for storage warehouse purposes as local conditions may demand.

Structures of this class may be divided into four distinct types: (1) All tracks and driveways on the lower level; (2) tracks on lower level and driveways on second level or both levels; (3) tracks on the second level and driveways on lower level only or on both levels; (4) tracks on both levels and driveways on the lower level or on both levels. Separation of track and street levels is not requird in the first, but is required for the second and third types. The fourth type is practically unknown in this country but the committee suggests that it should be given consideration in certain cases.

The principal considerations in the selection of the multiple-level plan for freighthouses are as follows: (1) relation of land values to freight revenue; (2) relation of building cost to freight revenue; (3) required operating capacity; (4) provision for future expansion; (5) value of storage space; (6) value of air right development; (7) relation of track and street grades and its effect on operating cost and capacity; (8) character of freight and its effect on cost of handling; (9) relative cost of handling freight in a long one-level house and in a shorter multiple-level house using mechanical means for handling freight between different levels. The mechanical means generally considered for handling freight from one level to another are: (1) Elevators, electric or hydraulic; (2) escalators; (3) gravity chutes; (4) conveyors of belt or endless chain type; (5) telfers. Only the elevator and escalator are in general use in freighthouses, on account of the diversity in size and weight of shipments. The elevator is more efficient and economical in operation than the escalator, as its use involves no reloading. It is cheaper in operation and is operated only when needed.

Photo-Recording Extensometer for Impact Tests

Instrument Developed at Bureau of Public Roads Gives High Multiplication Without Lag or Inertia Effects

AFTER two years of development a photo-recording extensometer of high sensitiveness and low lag or inertia has been developed in the laboratory of the Bureau of Public Roads, Washington. Preliminary tests of the instrument have proved entirely successful.

The primary use of the extensometer is expected to be in high-speed work such as impact experiments on bridges, for which service it was important to reduce mass effects to a point where they could not falsify the

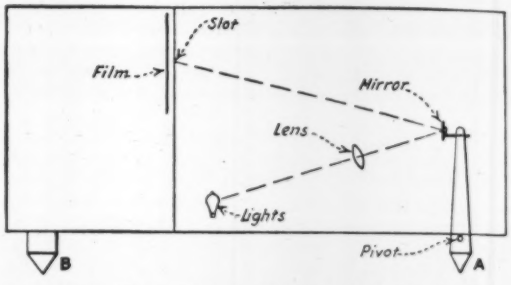


FIG. 1—MECHANICAL AND OPTICAL LEVER SYSTEM OF NEW EXTENSOMETER

indication of the instrument. In test, alternations of motion up to a speed of 100 per second were found to have no influence on the results.

A description of the instrument has just been prepared by Earl B. Smith, of the Bureau of Public Roads, who with A. T. Goldbeck did the principal work in developing the instrument.

For obtaining high magnification without the disturbing influence of the mechanical parts moving at high velocities and accelerations, the principle of the optical lever was applied, in connection with a single mechanical lever and a pivoting mirror. The arrangement is represented in diagram in Fig. 1, where *A* and *B* are the two gage points, *B* being fixed and *A* pivoted near its base and connected by a short link to a pivoting

FIG. 2—INTERIOR OF EXTENSOMETER

mirror. A beam of light from a lamp and lens is reflected by this mirror to a screen near the back of the case. A vertical slot in this screen allows a point of light to pass through to a moving film just back of the screen. Thus the indicating portion of the instrument

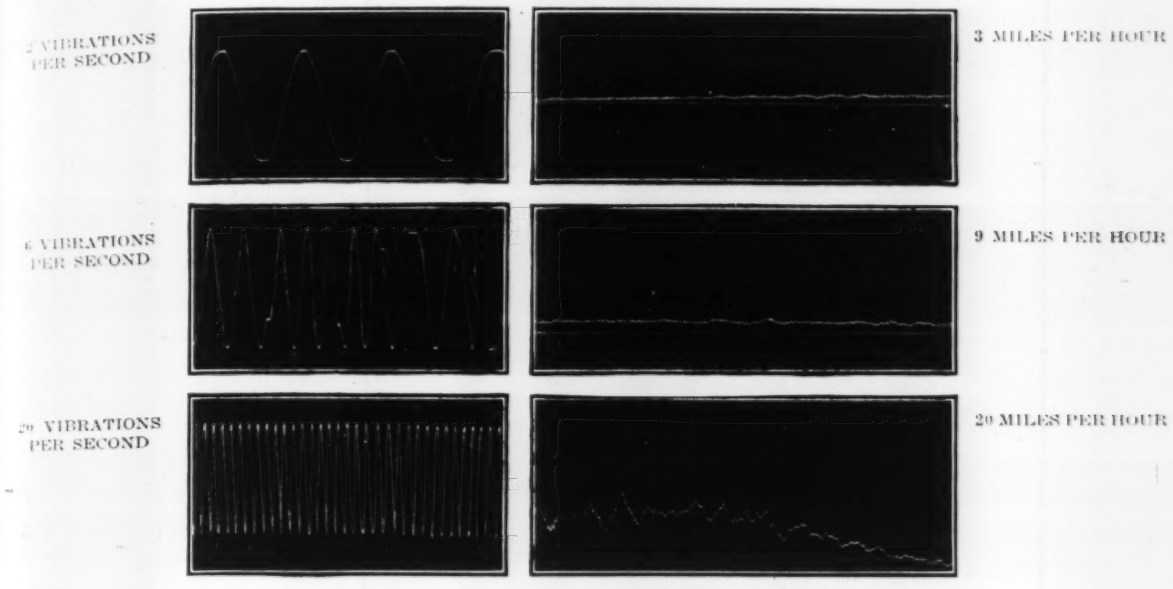

2 VIBRATIONS PER SECOND
3 MILES PER HOUR
6 VIBRATIONS PER SECOND
9 MILES PER HOUR
20 VIBRATIONS PER SECOND
20 MILES PER HOUR

FIG. 4—SPECIMEN RECORDS TAKEN WITH INSTRUMENT

has only two moving parts, the pivoted gage point and the pivoted mirror, whose combined inertia effect is extremely small. Magnifications of 500 or more are obtainable, but generally magnifications of 200 are provided for.

Recording is accomplished by moving the film by means of a small electric motor in the back of the instrument case, which drives the film rolls by worm and spur gearing. A 12-volt storage battery will operate both the motor and the lamp. Fig. 2 shows a view of the interior of the instrument with cover removed, the movable gage point being at the right and the film rolls in the middle compartment. The clamp shown below the instrument at the right is used in fastening it to a member whose extension or stress is to be measured.

The instrument is attached to a bridge member as represented in Fig. 3. Here can be seen also the arrangement of the gage points. The fixed gage points really consist of three side by side, of which the two outer ones are about $\frac{1}{8}$ in. longer than the middle one and are intended for use when the instrument is applied to a flat surface; on narrow plates or bars and on round members the middle gage point would be used.

Regular commercial "vest-pocket kodak" films, $1\frac{7}{8}$ in. wide, fit the instrument as normally made. For special work spools may be provided to take motion-picture films, which will permit of taking long records.

In tests of the instrument the movable gage point was oscillated by an electric motor drive at speeds ranging from 2 to 100 vibrations per second. Three typical records are shown at the left in Fig. 4. The total movement of the gage point in this test was 0.003 in., and it was found that the amplitude of the curve on the film was the same for all speeds. In these records the magnification was 250. The irregularities in slow-speed curves are due to operating by hand.

In further trials of the instrument it was applied to the members of several highway bridges under truck traffic. The right-hand diagrams in Fig. 4 represent the extensions in the lower chord of a fixed panel through Pratt truss bridge, when a 3-ton truck was run over the bridge at speeds of 3, 9 and 20 miles per hour. The large impact effects are evident.

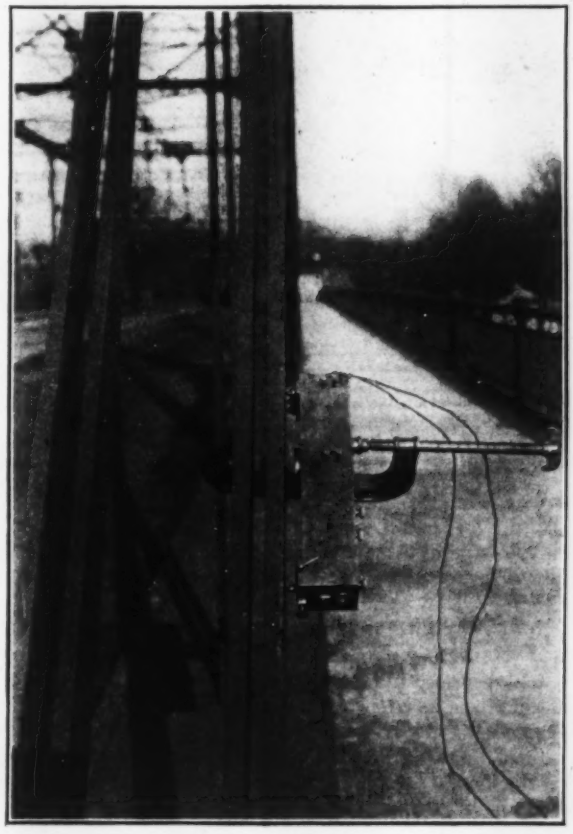


FIG. 3—INSTRUMENT MOUNTED ON BRIDGE DIAGONAL

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Good Soil Permits Rapid Pipe Laying in Deep Trench

REMARKABLE soil conditions account for the absence of bracing in the 16-ft. trench for a 36-in. reinforced-concrete sewer pipe being laid in Slocum St., near the Dixie Highway in Trenton, Mich. An occasional jack was used only as a precautionary measure for the protection of the workmen. No borings were made previous to construction but data collected after opening the trench showed a 3-ft. layer of top soil or flaky clay, and 8-ft. layer of yellow clay and then blue clay with no water in any of the material which was encountered.

LAYING 36-IN. CONCRETE PIPE IN 16-FT. TRENCH
Men standing on trench machine cut down the bank at the left which accounts for its ragged appearance compared with the right hand side. Progress of 100 ft. or more per day in cuts 14 to 15 ft. deep.

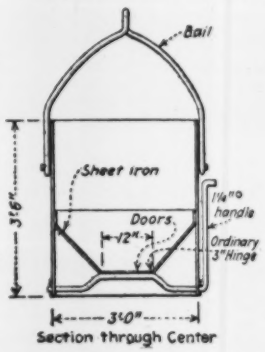
Normally the Pawling & Harnischfeger excavator used cuts a 27-in. trench but with side cutters is capable of making a 40-in. trench. Since the outside diameter of the pipe was greater than 40 in. spading of one bank was necessary. This work was accomplished by moving the machine ahead about 5 ft. and then men standing on the boom cut down the bank by hand. Further widening was unnecessary as pipe 4 ft. long was used which permitted the lower half of the joint to be filled with mortar from the inside and the upper half from the outside of the pipe. Even with the spading handicap, progress of 100 ft. or more per day was made in cuts 14 to 15 ft. deep, and a maximum of 80 ft. in a 17-ft. cut.

Hoad, Decker, Shoecraft & Drury, of Ann Arbor, were consulting engineers, for whom M. R. Dickie acted as resident engineer. The pipe was manufactured by the Independent Concrete Co.

Home-Made Concrete Bucket

BY G. W. MCALPIN.
Point Pleasant, W. Va.

A HOME-MADE controllable bottom-dump concrete bucket is shown in the accompanying sketch. It consists of an ordinary 3-ft. diam. dirt bucket from which the bottom has been cut and a new one, made of two doors and sloping sides installed. Doors are 6 in. x 24 in. of $\frac{3}{16}$-in. sheet iron, and hinged (with three hinges each) to the sloping sides, leaving an opening 12 in. x 24 in. They are kept at a sufficient distance from the bottom so as to swing wide open, and still not be damaged, when the bucket is set down. The sloping sides, also of sheet iron, are drawn in from the circumference of the old bucket to the 12 in. x 24 in. door opening so that the contents of the bucket will flow out easily.



CONCRETE BUCKET MADE OF 3-FT. DIRT BUCKET

A 1¼-in. diam. round iron handle bends and runs under the bottom of the bucket to form the latch, the operation of which is clearly shown in the sketch. By controlling the handle the doors may be opened to the desired width.

Advantages of Least-Squares Adjustment of Survey Observations

BY HUGH C. MITCHELL
U. S. Coast and Geodetic Survey, Washington, D. C.

ADVANTAGES of a least-squares adjustment of survey observations may be briefly considered with regard to triangulation and precise levels which form the basic control for many classes of detailed surveys. These advantages may be grouped in two general classes: The advantage of having the most probable results; and the advantage of having the final results.

The least-squares adjustment of a triangulation gets out of that triangulation everything that is in it. It takes into consideration every condition imposed by the observations, so that each adjusted length and azimuth and therefore each position, is as good as the combined observations will afford. This means a great deal. Neglecting this, a survey may be made with a high degree of precision (of instruments and methods), and

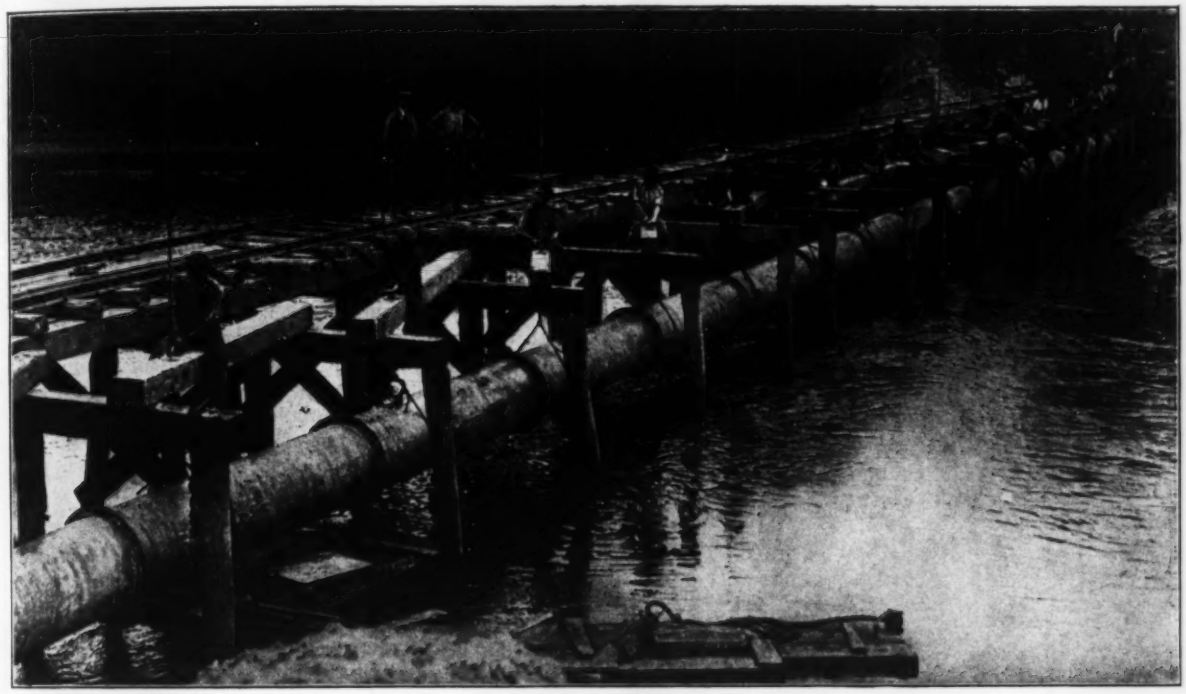
yet through injudicious computing, not necessarily inaccurate in its arithmetical operations, lose much of that accuracy which the observations were designed to secure. Thus a triangulation may be computed piecemeal and when separate parts are fitted together it may be found necessary to force a large discrepancy into some small link connecting two such pieces.

Having the final results from a triangulation has great economical value. Surveys based on such triangulation will then be final insofar as horizontal control is concerned, and results obtained for this control survey can be upset only by upsetting the observations themselves. There is no "cut and try" or "hit or miss" in the least-squares adjustment of a triangulation, a traverse, or a level net. Work based on such data will not be subject to change because of a revision of basic data; if more accurate control is required it can be secured only by obtaining more accurate observations. By a least-squares adjustment of the control a survey may proceed in any direction, by any route, across the net of the control, and the engineer has no worry about running into some uneliminated errors.

The city which makes a precise survey of its area and neglects to have a least-squares adjustment made of that survey is limiting its use—cutting down its efficiency to a very small percentage of its full value. It is much like the man who builds a large plant, then uses only a small portion of that plant and that for storage purposes. Another form of the same neglect of opportunity, for that is what it is, is where a city makes detailed and accurate maps of its area, and then, by refusing to publish them, selfishly limits their use to its own departments, and even to them makes their use difficult and uneconomical. The publication of such maps would put them not only in the hands of the city employees and of local private engineering concerns, but would give them also to the map using public.

Thirty-Inch Force Main Lowered Into Subaqueous Trench

IN ORDER to connect the pumping station of the Des Moines, Iowa, municipal water plant with the city, it was necessary that the 30-in. force main be carried across Raccoon River. A railroad trestle was first constructed and from this a locomotive crane excavated a trench in which the pipe was to be placed. Alongside the railroad trestle pile bents were put in at each joint in the force main. Pipe was then hung from these two-pile bents as indicated in the accompanying view, by means of long full-threaded 1-in. rods fitted with hook bolts. When the lowering was ready to be done a man was placed at each threaded rod and at a given signal gave a full turn to the nut on the rod. Lowering was done in three hours and only six hours before a flood which carried the trestle away.



LOWERING 30-IN. FORCE MAIN BY MAN-POWER

Alvord, Burdick & Howson were consulting engineers on the job. A. T. Luce was the contractor's superintendent, L. A. Mullins being the contractor.

Priming Dynamite Cartridges a New Way

ONE of the drawbacks in the use of explosives in cold weather, says a recent issue of the du Pont magazine, especially with the cap and fuse method of priming, is the difficulty of tying the fuse securely to the dynamite cartridge so that it cannot pull out. Misfires and burned up charges often result from careless priming, both among farmers and miners. The fuse with the cap attached must be securely fastened to the dynamite cartridge so that the side spit of the fuse cannot ignite the dynamite. A new kink in priming consists of the standard method of priming in the side of the cartridge near the top, though fastening the fuse with a tarred string. A piece of tarred string

15 in. long and about as thick as the twine used by hardware dealers for tying up about a 5-lb. package of nails, does away with tying knots.

After the cap with fuse attached is inserted in the dynamite cartridge, two or three turns are taken with the tarred string about the fuse about an inch from the cap, and then two turns are taken around the dynamite cartridge and the fuse. The priming is then finished with as many more turns around the fuse as will use up the string. This makes a tight firm operation which, if properly carried out, will hold the cap securely in place.

Platform on Rollers Used in Setting Heavy Granite Columns

IN DELIVERING and setting up 23-ton granite columns for the Anglo & London Paris National Bank Building in San Francisco, the contractors used a low-bed trailer on which each column was loaded with the column footing resting on bags of sand carried by a platform on rollers. As the top of the column was raised the platform rolled forward on the trailer bed and the sand cushion prevented any chipping or snipping of the finished column base. When the column swung free in the air the shears carrying the tackle were drawn back toward the building by block and tackle until the column hung over the base and could be lowered to the place and plumbed. Some of the columns were set within a period of thirty minutes after arriving on the job.

GRANITE COLUMN BEING RAISED FROM TRAILER
Note sand bags at base of column on rolling platform which has moved forward from rear of trailer.

Six such columns were set. A pair of shear legs were used for the first two, but for the remaining four the space available at the footing did not permit of the use of shear legs nor was it convenient to use a derrick with tackle dropped from the top of the structure. Accordingly a 55-ft. gin pole 18 in. square was substituted for the shear legs first used. This is said to have been fully as safe and satisfactory in operation as the shears.

The tackle consisted of a two-part derrick fall and a lifting fall with four parts, making six parts in all, through which a ⅝-in. cable was reaved.

The columns were supplied and set in place by the McGilvray-Raymond Granite Co. of San Francisco under the personal supervision of Harry McGilvray, superintendent of construction.

From Job and Office

Hints that Cut Cost and Time

Wide Area Covered by Pile Cut-Off Saw

IN THE construction of the Hudson Ave. generating station for the Brooklyn Edison Co. extremely heavy loads to be imposed upon foundations required the driving of pile foundation supports very close together, the spacing in some sections being on 3-ft. centers. With them so close together there was presented to the contractor a problem of wholesale cutting of piles to grade. The cut-off saw herein described and pictured was developed by the Frederick Snare Corporation, contractors, and it worked so efficiently that more time was required to clean up after the cutting had been done than was used in the actual cut-off operations.

As indicated in the accompanying photograph, the machine has a motion in both lateral and longitudinal directions. Lateral motion of the saw is provided by mounting the carriage on crane rails with an 11½-ft. span. These rails are clipped to stringers resting on heavy steel I-beams. The frame is braced laterally with timbers and by light angles diagonally. This crane rail frame is mounted upon 16-in. wheels (there being four sets of wheels spaced at about 25-ft. centers) running on 40-lb. railroad rails set on heavy planking

PILE CUT-OFF SAW, OPERATING IN TWO DIRECTIONS

From Job and Office

For Contractor and Engineer

which rests upon piles that have been cut off and blocked.

The 40-in. circular saw is mounted in an A-frame and driven from the saw carriage by belt. Power for the saw is supplied by a 40-hp. motor. In order to move the saw carriage laterally an endless cable passes through snatch blocks at either end of the track and then over a reversible steam-driven cable drum on the saw carriage.

The whole structure moves forward by being wedged from behind. As rail sections are vacated they are taken up and placed in front so that but two short rail lengths are in use at a time.

This rig has been found extremely effective and operates as well on land as over water. When dismantled its parts can be easily handled by a 20-ton locomotive crane.

G. L. Knight is designing engineer for the Brooklyn Edison Co., and Robert K. Munroe is the resident engineer.

Compressed Air Reheated to Drive Water Trench Excavating Equipment

RATHER an ingenious method is being used in furnishing air power to excavating machinery in Cleveland where the city is laying several miles of water intake mains from Kirtland Pumping Station to the new Baldwin Reservoir and purification plant. Because it was felt work should progress rapidly as possible with as little obstruction to street traffic and with every precaution being taken to avoid defacing residences and buildings along the route. Use of steam shovel equipment producing, large volumes of soft-coal smoke was impossible. Instead, compressed air was employed for all machinery. As the work is done both day and night it was also necessary to avoid noisy exhaust of steam engines as much as possible.

An air compressor plant with two angle compound units was established at a central point. They have a rated capacity of 784 cu.ft. per minute each at 250 r.p.m. and supply an abundance of air at 125 lb. pressure. Each compressor is driven by short belt connection from a 220-volt three-phase slip-ring motor of 150 hp.

From the compressor house a 6-in. main leads about 4,000 ft. north and a 4-in. main for about 3,600 ft. in the other direction along the trench. These mains are equipped with numerous tees to which the various machines can be connected.

The unique feature of the machinery operation lay in the fact that in order to have compressed air of sufficient pressure to drive equipment efficiently it was reheated. Two-inch hose connected the shovel to the main. This hose is led through one of the openings in the side of the sectional track and connected with the hollow swivel pin on which the shovel revolves. Thence it runs into the boiler and there reheated by means of a light wood fire which is maintained in the boiler for that purpose.

The work has been under the close personal supervision of A. B. Roberts, Director of Utilities, City of Cleveland; A. V. Ruggles, Commissioner of Water; and G. W. Bowers and F. R. Sullivan, assistant engineers in direct charge of the work. The contractor is Peter F. Connolly, Boston, Mass.

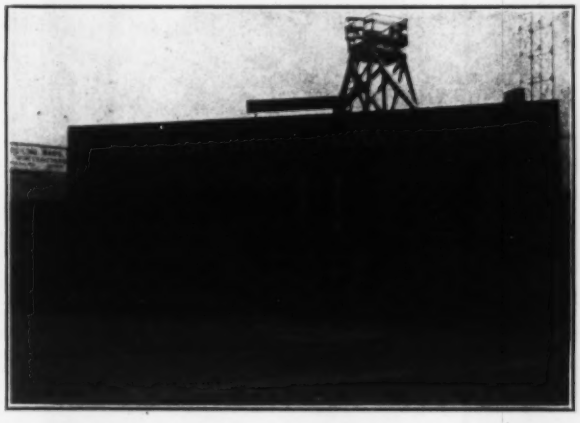
STEAM SHOVEL REFITTED FOR COMPRESSED AIR

Material from which this article was prepared was supplied by the Sullivan Machinery Co., whose air compressor plant was used.

Signboard Gives Bridge Erection Progress

BY WILLIAM A. SCHUERMAN
C. C. C. & St. L. Ry. Co., Cincinnati, Ohio

KEEPING the public informed as to progress of construction which has a general appeal is well illustrated by a signboard erected at the site of construction of the Belle Isle bridge at Detroit. The board



PROGRESS CHART ON BELLE ISLE BRIDGE WORK

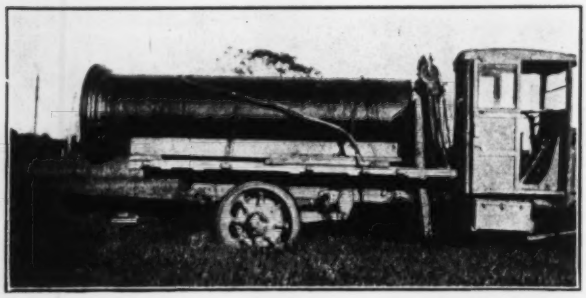
is placed in a conspicuous position on the approach to the bridge and all who cross over to Belle Isle on the wood bridge must pass by the sign.

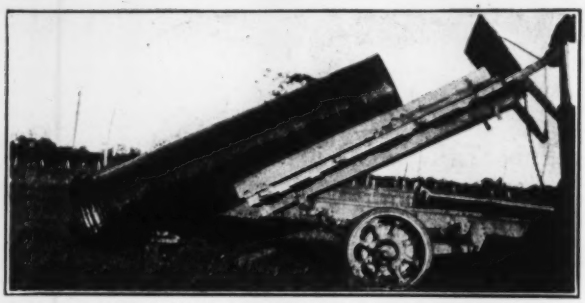
The accompanying view shows the sign as it appeared in December, 1922. All the important facts are indicated, the chart can be easily interpreted and it is always kept up to date. Boards similar to this one might well be erected to indicate progress on all important construction jobs.

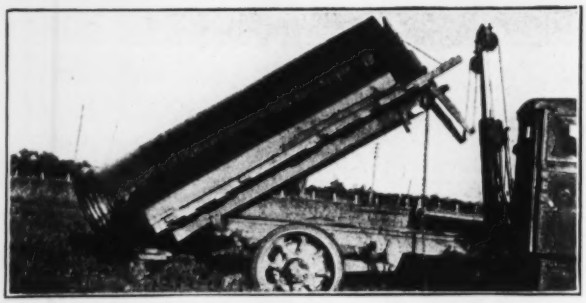
Handling 36-In. Cast-Iron Water Pipe

IN HANDLING 2,200 tons of 36-in. Class D water pipe for replacement at the feed main for the City of Schenectady, the following method was used:

At the railroad siding, pipe was loaded from cars to a motor truck by means of a standard railroad yard crane and a pair of pipe hooks. The rigging on the truck was a pneumatic dump body with sides removed and three 2-in. planks bolted crossways on the truck platform, one at each end and one in the middle. To







UNLOADING 36-IN. PIPE FROM MOTOR TRUCK

these planks were bolted two 8x8-in. timbers spaced far enough on either side of the center of the truck so that when the 36-in. pipe was lowered between them it was kept from rocking.

With the pipe in place on the truck, a binder chain was thrown over the pipe from the one side of the frame to the other and made tight with an elm binder. In loading pipe on the truck, the bell end was always placed toward the back so that it hung over the truck end.

With the truck backed into position at delivery points the hoist was operated until the pipe would slide. When the bell touched the ground, the truck body was chained so that there would be no back lash as the pipe left the back of the platform. A 10x10-in. timber was placed behind the truck so that as the pipe dropped the timber would catch the pipe about 3 ft. from the spigot end. By the time the pipe left the end of the platform, there was only a drop of a few inches to the timber.

With a 3½-mile haul each way, one truck driver with three helpers unloaded as high as 15 sections a day by this method and not a single pipe was damaged in handling the entire 2,200 tons. The contractor who handled the pipe was Ellis C. Edgar, of Scotia, New York.

From Job and Office

Hints that Cut Cost and Time

Tightening Tension Bars of a Bridge by Heating and Upsetting

By Wm. J. Titus
Bridge Engineer, Indiana State Highway Commission, Indianapolis

DURING 1921 the Muscatatuck River was deepened and widened for several miles of its length in Jackson Co., Indiana, and it was necessary for the state highway commission to lengthen its bridge over this stream near the Millport Knobs, and to make extensive repairs on it, including the tightening of the diagonal truss members. For the latter operation an ingenious method was used, the bars being heated to forging temperature and upset by sledging, without removal from place.

The bridge was built in 1884, with two pin-connected steel truss spans, a 158 ft. 4 in. double-intersection through truss with parallel chords, and a 69 ft. 4 in. south approach span, which is a pony Pratt truss. In the 1921 improvement the river was widened 60 ft. on the north side, so that it was necessary to remove the old limestone abutment and replace it with a concrete pier with much deeper foundations resting on 35-ft. wood piles. A new 70-ft. pony Pratt truss was then added at the north end of the present structure, together with a new concrete abutment resting on long piles. The superstructure of the old bridge was in a fair state of preservation, but it would have been very difficult and expensive to dismantle and re-erect it in order to permit the dredge boat in the river to pass. A new main truss span would have been quite expensive, so that an agreement was arranged with the dredging contractor whereby the dredge boat was partially dismantled in order to move it beneath the old steel span. The state was thus enabled to place the old bridge in excellent condition at a total cost of $17,000.

During the long life of the bridge, several loop-bar truss diagonals of the main span had become loose, and there was a great amount of noise and rattle under moving loads. It was thought advisable to correct this feature at the time the bridge was repaired. But a difficult problem was presented: The old loop-bars were not provided with turnbuckles, and these could not be installed without two welds in each bar. It was not possible to substitute new eyebar members without supporting the old truss upon falsework.

At first it was planned to replace the diagonal members one at a time with new bars with turnbuckles and a yoke at each end, which could be inserted in the box-section top chords and around the panel-point pins without the necessity of removing the pins. This

From Job and Office

For Contractor and Engineer

method of repair was clumsy and at best unsatisfactory. After further study there was finally worked out a very simple and ingenious method of shortening the members, by heating and upsetting them.

The first thing done was to determine how much the loose loop-bars should be shortened. A gage was made of ½-in. round reinforcing steel, about 4 ft. long, with the ends turned at right angles about 2 in. long and sharpened to form prick points. The loop-bar diagonals were then in turn wedged up tight against the lower panel-point pin *A*, Fig. 2, and a prick mark *D* made at gage length from the center of the pin, by striking the end of the gage with a light hammer. The wedge at the lower end of the loop-bar was then removed, and the bar was wedged down tight against the upper panel-point pin *B*. One point of the gage was again placed at the center of the lower pin *A*, and another prick point was made at the upper end of the gage, at *C*. Care had to be taken that all sag in the loop bar was removed, in order that the distance between the two prick marks *C* and *D* should indicate the exact amount which the bar must be shortened in order to carry its share of the stress in the panel. The distance between prick points *C* and *D* varied from ⅛ in. in some cases to as much as 1 in. in others. The diagonal bars averaged about 1x1½ in. in section.

These gage marks were too far down on the diagonal members for convenience in measuring while the bar was being shortened. The two prick points were therefore transferred nearer to the middle of the bar (*C'* and *D'*), and a third point was established at gage length below *D'*.

The loop-bar was anchored to its neighboring bar to prevent sagging, and was then heated to a bright cherry red by the use of a one-man forge placed on a movable platform. The heat was applied within the gage distance, a metal shield being used to prevent the heating of the neighboring diagonal, which was of course carrying all of the shear in the panel. To have allowed this neighboring diagonal to heat would have permitted its elongation under load and the serious distortion if not failure of the truss. When the diagonal bar had been heated to the proper temperature, the forge was removed and the member was quickly upset by driving with a sledge at the lower end, the upper end being wedged down tight against the upper pin. The driving was done against a heavy backing-out rivet punch, with one end placed against the lower loop of the diagonal. It was necessary to use care that the member did not buckle under the driving, instead of upsetting as desired.

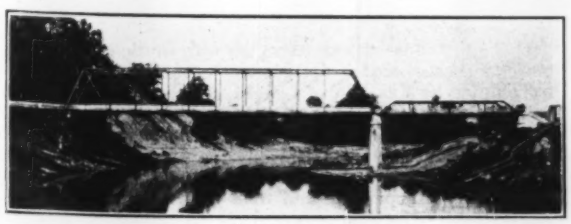


FIG. 1—LOOSE LOOP-ROD DIAGONALS OF 158-FT. SPAN TIGHTENED BY HEATING AND UPSETTING

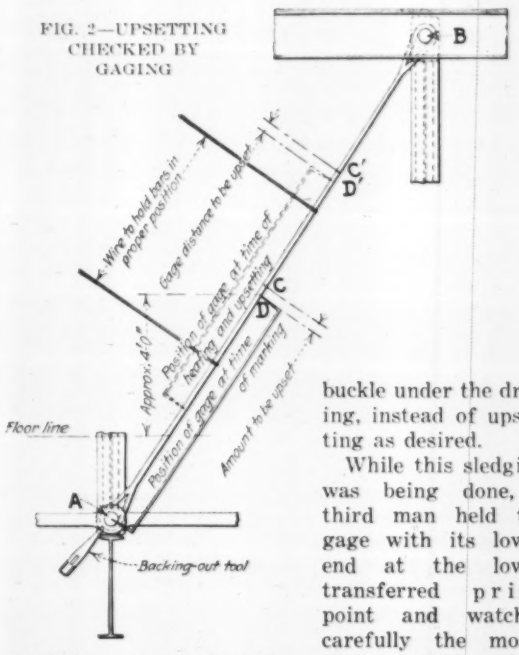


FIG. 2—UPSETTING CHECKED BY GAGING

While this sledging was being done, a third man held the gage with its lower end at the lower transferred prick point and watched carefully the movement of the upper end of the gage toward the upper prick point *C'*. In order to make the proper allowance for shrinkage during the cooling of the metal, it was necessary to stop the driving when the upper gage point was approximately ⅛ in. from the upper prick point. Sometimes the member would get too cool before the necessary amount of upsetting had been completed, and it would be necessary to reheat it.

Upon completion of the upsetting to the proper point, the bar was allowed to cool, the wedges at the upper end were removed, and the bar was tested to determine its tightness and tension, as compared to the other diagonal member in the same panel. If the member had been shortened too much, the other member would be loose, and the distribution of stress in the entire truss would be disturbed. It was therefore necessary in one or two cases to reheat a diagonal member and allow it to elongate from the stress existing in it. By careful work on the part of the men, it was possible to so adjust the length of the diagonal members throughout the bridge that the unit stresses existing in them were believed to be very nearly uniform.

Ten diagonal members were tightened in this manner, at a total cost of $97.86 for labor, exclusive of supervision, making a unit cost of approximately $10 for each bar. This method was simple and expedient, and the cost was several hundred dollars less than it would have been by the use of any other method which was considered. The results were very gratifying, as all the rattle of loose diagonal members was eliminated and the strength of the truss was practically doubled. The entire structure has since been carefully cleaned with wire brushes and given three coats of paint.

The work was done by the Oregonia Bridge Co., in connection with their contract for lengthening the old bridge and adding the new pier and abutment. The method of tightening the loop-bar diagonal members was worked out largely by R. T. Spencer of that firm, who was in direct charge of the work for his company. The work was done under the supervision of W. R. Britton, field bridge engineer for the Indiana Highway Commission.

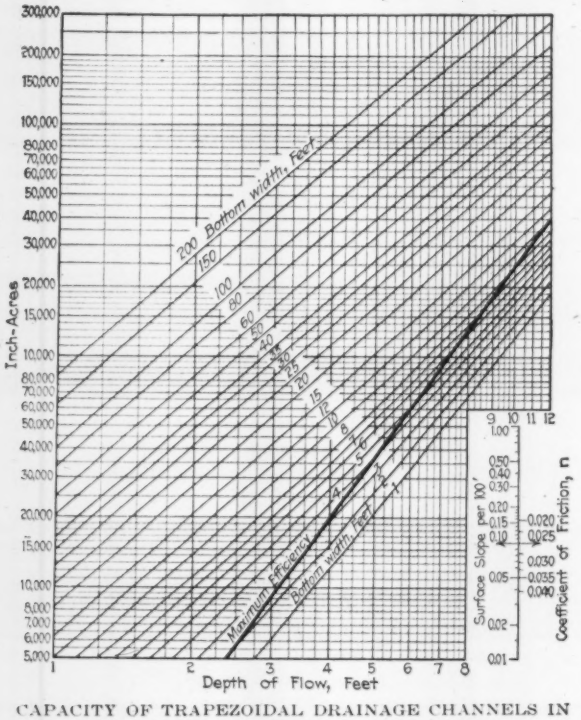
Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Diagram Giving Capacity of Trapezoidal Channels of 1 to 1 Slope in Inch-Acres per 24 Hours

Sir—Herewith is a diagram which I have calculated and plotted and have used during my drainage practice. It was part of a paper on "Design of Open Ditches" that was read before the Association of Ontario Land Surveyors Feb. 21.

The diagram has been prepared to give immediate comparison between the cross-section of the ditch and the area of the watershed. An ordinary provision is 1 in. of runoff in 24 hours, and the diagram shows on the scale of ordinates the inch-acres capacity per 24 hours of trapezoidal channels with side slopes of 1 to 1. Values are calculated and plotted with $n = 0.025$ and $s = 0.10$ per 100 ft. For these values of n and s the capacities of the ditch with different bottom widths and different depths of flow are read directly on the diagram. The velocity, and therefore the



CAPACITY OF TRAPEZOIDAL DRAINAGE CHANNELS IN INCH-ACRES PER TWENTY-FOUR HOURS

Sides slopes, 1 to 1. $n = 0.025$. $s = 0.1$ per cent with corrections for other values

inch-acres capacity, varies as the square root of the surface slope of the water, and when the slope is greater or less than 0.10 per hundred the capacity may be increased or diminished by a ratio representing this square root; an auxiliary scale is drawn for this purpose showing a range of surface slopes from 0.01 to 1 ft. per hundred, and by applying a pair of dividers to this scale and transferring to the logarithmic scale of inch-acres the capacity is indicated at once. Also the velocity varies inversely with the coefficient of friction, and the inverse ratio of any desired coefficient of friction to the coefficient 0.025 is also indicated on the auxiliary diagram and can be transferred with dividers to the scale of inch-acres. Allowance for any surface slope and for any coefficient of friction may be made in one operation with a pair of dividers and the required capacity immediately determined. The following are illustrative examples:

n	s	Depth, Ft.	Bottom Width, Ft.	Capacity Per 24 Hr. in Acres
0.025	0.10	6	10	10,000
0.025	0.05	6	10	7,000
0.020	0.10	6	10	12,500
0.020	0.15	6	10	15,000
0.035	0.05	6	10	5,000
0.040	0.15	6	10	7,500

The line on the diagram marked "maximum efficiency" indicates those sections for which a given sectional area provides the maximum carrying capacity.

The diagram was originally calculated by Kutter's formula, but has been recently checked by Manning's formula with the result that there is no noticeable difference.

GEORGE A. MCCUBBIN.
Surveyor and Civil Engineer.

Chatham, Ont., Feb. 17, 1923.

The Motor Truck Transportation Problem

Sir:—I note with interest the article in *Engineering News-Record*, March 1, 1923, p. 378, on "Solving the Motor Truck Overload Problem." There appears in the same issue an article on the traffic situation in large cities; a problem that is indeed growing to alarming proportions. Both subjects have a particular bearing one on the other and both on the community.

The tremendous battle for existence fought by our municipal carriers and great railways is a subject for serious consideration and of vastly more importance than whether a truck should run empty or carry twenty tons. The primary question as I see it is whether or not motor truck transportation is economically sound. Your article brings out prominently the proper co-ordination of the roadbeds and loading on railroads and should have shown that this well preserved balance was made possible by the financial earnings of the carrier itself and was due in no way to support from the state. The question then arises, does the heavy motor truck, that is really a menace to our railroads, pay its proportionate share of damage done to our roads, and is it capable of so doing without making the cost of this type of transportation prohibitive? Someone has said that competition is the life of trade and in so far as this applies to the survival of the fittest it is well said, but for the public deliberately to finance one side of the competitive issue and utterly disregard the other is an unsound policy. If the community financed the upkeep of the railroad roadbeds and yards, would they not be justified in expecting a corresponding reduction in freight rates? Yet on the other hand the public goes on building and maintaining roadbeds for another type of carrier that has not yet by any means proved itself as economically sound as the railroad, thus fostering a condition of railroad breakdown similar to that Canada is facing.

If the motor truck could by its own strength eliminate the railroad either as a short or long carrier we are naturally justified in giving it moral support and it would not need financial aid. Your article suggests that some manufacturers need heavily loaded and fast trucks. This being true they can well afford to pay for it. To your suggestion that communities might be kept employed repairing roads, I should reply that I have no desire personally to move my money from one pocket to the other, nor can I see the advantage.

If the motor truck can carry its own burdens, it is a commercial success and a decided advantage to society, but in my opinion as a carrier of freight, it is a miserable economic failure particularly as applied to a distance carrier.

I could go on indefinitely citing damage unpaid for by this class of transportation such as public protection, and traffic congestion, but will conclude with the sincere wish that some enterprising and able writer will soon put the motor truck before your readers in its proper light.

Camden, N. J. WILLIAM H. ASPDEN.
March 7, 1923.

Another Method for Deriving Cost Curves

Sir—In reading the article on "Cost Curves for Building Estimates" in your issue of Feb. 15, it seemed to the writer that the matter could be much simplified by using the well-known and easy method of substituting the known values in the stated equations from which the constants can be readily established. Thus, using the calculated examples (A) and (C), as is done by the author, we obtain the two equations:

$$\text{Building (A)} \quad 284.89 = 1{,}267\ a + K$$
$$\text{Building (C)} \quad 533.07 = 4{,}928\ a + K$$

Solving these equations we obtain: $a = 0.0678$ and $K = 199.00$; and the equation of unit costs becomes

$$x = 0.0678 + 199/y.$$

The calculated examples are taken too close together to give an accurate curve if it is to be much extended, but all of the examples should be used in establishing the constants of the equation. This can easily be done by using the method of least squares for cases in which the number of unknown quantities is less than the number of equations. The procedure is perhaps too well known to be given space here, but the results give $a = 0.0679$ and $K = 198.21$. These vary but slightly from those given above because the range of values is very small. F. W. DALRYMPLE.

Washington, D. C., Feb. 27, 1923.

Earth Pressure Formulas and Their Inconsistencies

Sir—In *Engineering News-Record* of Feb. 8, p. 270, M. Hirschthal states that the standard formulas for the lateral pressure of earth are inconsistent, since for the case of a vertical wall and horizontal fill the pressure is given as $\frac{1}{2}wh^2\tan^2\frac{1}{2}(90° - \phi)$ while the weight of the corresponding "wedge of pressure" is $\frac{1}{2}wh^2\tan\frac{1}{2}(90° - \phi)$ or a ratio of $\tan\frac{1}{2}(90° - \phi)$ to 1, while in the case of a vertical wall and fill at the angle of repose the total pressure is $\frac{1}{2}wh^2\cos\phi$, which is also the weight of the wedge.

There are two errors in the above argument. The first is the assumption that the plane of rupture bisects the angle between the vertical wall and the plane of repose in both cases; this is only true for the special case of a horizontal fill. The second is the use of the formula $\frac{1}{2}wh^2\cos\phi$, which is derived by the Rankine theory without any reference to a wedge and acts obliquely.

To make this perfectly clear, the following formulas for the lateral pressure against a vertical wall are tabulated:

I. According to the Coulomb theory; the pressure assumed to act normally to the wall, i.e. horizontally.

II. According to the general wedge theory; the pressure always inclined to the normal at an angle ϕ', where $\tan\phi'$ is the coefficient of friction between wall and fill.

III. According to the modified wedge theory; ϕ' assumed equal to ϕ.

IV. According to the Rankine theory; pressure always parallel to the surface of the fill. Since no wedge is assumed we cannot have any values for the weight of the wedge or the wedge angle.

In all these theories we assume that the angle of natural slope is equal to the angle of internal friction. To save space only the results for the cases of horizontal and maximum sloped fills are given. The symbols in the formulas are:

W, weight of the wedge;
P, total pressure;
H, horizontal component;
ϕ, angle of natural slope;
ϕ', angle of friction between wall and fill;
θ, angle between vertical wall and plane of rupture.

The values of the table were computed by drawing the equilibrium triangle of the three forces acting on the wedge and obtaining the relation between H and W in terms of the angles. Simplification gives the ratio H/W as above. The value for θ is found by substituting the value for H from the first row of the table. The detail is omitted because of its length; note however that if we set ϕ for ϕ' in Theory II, there result the values under III; and with zero for ϕ', the values under I. A value for the ratio H/W of zero, since H is not zero, can only mean that the wedge is infinite, in other words, the plane of rupture coincides with the plane of slope. The inconsistency does exist in these formulas, but not as Mr. Hirschthal pointed out.

To see the relative values more clearly, assume the case of $h = 20$ ft., $w = 100$ lb. per cu.ft., $\phi = 34$ deg., $\phi' = 25$ deg. Then the following values result:

	Horizontal Fill				Fill At Natural Slope			
	I	II	III	IV	I	II	III	IV
H.....	5,650	4,620	4,300	5,650	13,800	13,800	13,800	13,800
P.....	5,650	5,100	5,200	5,650	13,800	15,200	16,700	16,700
$\frac{H}{W}$	0.532	0.360	0.442	.....	0.000	0.000	0.000	.....
θ.....	28° 00′	32° 40′	32° 10′	.....	56°	56°	56°	.....

The above is in no way intended to prove or disprove any theory; that can only be done by experimental data.

Brooklyn, Feb. 11, 1923. JACOB FELD.

HORIZONTAL FILL

	I	II	III	IV
H	$\frac{1}{2}\,wh^2\tan^2\frac{1}{2}\,(90°-\phi)$	$\frac{1}{2}\,\frac{wh^2\cos^2\phi}{(n+1)^2}$ where $n=\sqrt{\frac{\sin(\phi+\phi')\sin\phi}{\cos\phi'}}$	$\frac{1}{2}\,\frac{wh^2\cos^2\phi}{(1+\sqrt{2}\sin\varphi)^2}$	same as I
P	H	$\frac{H}{\cos\phi'}$	$\frac{H}{\cos\phi}$	H
$\frac{H}{W}$	$\cot(\theta+\phi)$ or $\tan\frac{1}{2}\,(90°-\phi)$	$\frac{\cos(\phi+\theta)\cos\phi'}{\sin(\phi+\phi'+\theta)}$	$\cot(\phi+\theta)$	.....
θ	$\frac{1}{2}\,(90°-\phi)$	$\tan\theta=\sqrt{\tan(\phi+\phi')[\tan(\phi+\phi')+\cot\phi]}-\tan(\phi+\phi')$	$\tan\theta=\frac{\sqrt{2}\cos\phi}{\cos 2\phi}-\tan 2\phi$	.....

FILL AT NATURAL SLOPE

H	$\frac{1}{2}\,wh^2\cos^2\phi$	same as I	same as I	same as I
P	H	$\frac{H}{\cos\phi'}$	$\frac{H}{\cos\phi}$	$\frac{H}{\cos\phi}$
$\frac{H}{W}$	$\cot(\phi+\theta)=0$	$\frac{\cos\phi'\cos(\phi+\theta)}{\sin(\phi+\phi'+\theta)}$	$\cot(\phi+\theta)=0$	.....
θ	$90°-\phi$	$\tan\theta=\frac{\cos\phi\sin(\phi+\phi')}{\cos\phi'-\cos(\phi+\phi')\cos\phi}$	$90°-\phi$	.....

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

Amendment of the New York City zoning regulations which reduced from 150 to 75 ft. the permissive height of buildings on Fifth Ave. was sustained on March 13 by a Justice of the State Supreme Court.

By a bill recently introduced in the New York State Assembly the state is authorized to issue $5,000,000 for its share in the elimination of certain grade crossings by the Long Island Railway Co.

The Interstate Commerce Commission will hold a meeting in Denver Colorado, April 16, to discuss the consolidation of certain Western railroads. The Colorado Society of Engineers has appointed V. A. Kauffman to be present as an observer for the engineering society.

Senator O'Brien has introduced into the New York State Legislature an amendment to the engineering licensing law to exempt from examination and payment of fees persons employed as civil engineers in any department of the state.

No communication from Henry Ford has been received by the Federal Power Commission at this writing since the authorizing of a preliminary permit in his favor for the High Dam on the Mississippi. Despite the rather exacting conditions in the permit, it is anticipated, however, that he will accept it.

Application has been made to the Interstate Commerce Commission by the Great Northern R.R. for permission to issue $60,000,000 in 5 per cent gold mortgage bonds, of which the railroad proposes to sell $20,000,000 immediately. Approximately $55,000,000 of the issue is said to represent expenditures made by the railroad between 1911 and 1921 on betterments.

Harbor and port construction work calling for an appropriation of 57,050,000 yen ($27,945,975) is contemplated in the program to be introduced into the present session of the Japanese Diet. The principal ports that will benefit by the bill, if it is approved, are Yokohama, Kobe, Nagasaki, Moji, Tsuruga and Shimonoseki. According to a recent issue of *Commerce Reports* Kobe is to receive the greatest part of the appropriation, or about $14,500,000.

The Asia Development Co., one of the new American firms to operate in the Orient, has signed a contract with the provincial government of Shantung for closing the break in the Yellow River in Li-Chinhsien Shantung. Work involves the repair of the 3-mile break in the dikes and the retention of the river in its old course. The contract is said to involve $1,500,000. Paul P. Whitham, a Seattle engineer who served for several years as special agent and trade commissioner for the Bureau of Foreign and Domestic Commerce is president of the company.

Hoover Proposes Interstate Treaty for Superpower Plan

Washington Correspondence

The next step toward the realization of the superpower plan in the Northeast, George Otis Smith announced on Mar. 10, will be a conference between members of the superpower advisory board with representatives of the eleven state commissions having jurisdiction over public utility matters. Commerce Secretary Hoover believes the most workable scheme to insure the co-ordination of these regulating bodies would be the drafting of an interstate treaty along the lines of the Colorado River Compact.

An early effort will be made to have a legal study undertaken of the existing state statutes or regulations which would interfere with or hamper the carrying into effect of the superpower project.

Albany Engineers Endorse Plan to Merge State Agencies

In a resolution passed recently by the Albany Society of Engineers, endorsement was given of the proposed Senate resolution which would amend the state constitution providing for the creation of nineteen civil departments. At the same time the resolution of the engineers contains a recommendation that the words "engineering and" be inserted so that the proposed new department may read "engineering and public works." The resolution is based upon the view that because of the relation of engineering to all public works specific recognition should be given, and because the successful and proper planning, prosecution and ultimate effectiveness and utilization of all public works are dependent upon proper engineering design, supervision of construction and operation.

D. W. Davis Made Assistant Secretary of Interior

D. W. Davis, formerly Governor of Idaho, has been appointed a special Assistant Secretary of the Interior. He was added to Secretary Work's staff because of his knowledge of irrigation and reclamation matters.

Mr. Davis served as Governor of Idaho for two terms, from January 6, 1919 to January 1, 1923. His home is at American Falls. He was a member of the Idaho State Senate in 1912 and in 1914. While Governor of Idaho he formed the Western States Reclamation Association. He has been president of that organization since its founding in 1919.

Mr. Davis was born in Wales in 1873. He came to America in his infancy. During his boyhood he worked as a coal miner in Iowa. While still a youth he moved to Idaho. He has had wide experience in all of the questions affecting the public lands.

Action on Demolition of High Bridge Postponed

Numerous Protests Hold Up Board of Estimate Plan to Tear Down Structure

Protests by engineers, architects and others against the tentative decision to tear down High Bridge (*Engineering News-Record*, March 15, p. 508) made on March 16 before the Board of Estimate and Apportionment, New York City, were followed by the adoption of a resolution requesting the Department of Plant and Structures to "re-examine, investigate and report with all convenient speed" in the matter of removing piers and some of the present short arches and building a longer arch to carry the Old Croton Aqueduct across the Harlem River. The preamble to the resolution stated that the Department of Water Supply had reported on Jan. 30 and Feb. 27 of this year that surveys of the present structure and borings in the bed of the Harlem River have shown that it would be feasible to remove these piers and substitute a single arch for them and the arches that would be destroyed.

Many Protest

Among those who requested that the bridge be spared because of its engineering, architectural, and historic interest were Charles M. Leavitt, President of the American Institute of Consulting Engineers; E. S. Jarrett, Daniel E. Moran, Lincoln Bush, and Ralph Modjeski, representing the New York Section of the American Society of Civil Engineers; Nelson P. Lewis, former Chief Engineer of the Board of Estimate, representing the Russell Sage Foundation; Mr. Barber and Arnold W. Brunner, representing the American Institute of Architects.

During the discussion, High Bridge was spoken of as a worthy memorial to John B. Jervis, engineer for the Croton water supply. Donn Barber, of the American Institute of Architects, declared that it would be criminal to tear down that historic structure, which he declared is "one of the finest examples of early American engineering and architecture."

Built in 1836

The general plan for the Croton supply, as proposed by Major D. B. Douglas, was approved by the City Council on March 11, 1835, and later on by a popular vote of 17,330 to 5,963. Major Douglas was made chief engineer, located the aqueduct and made plans for it.

These plans were modified in some details and the aqueduct was constructed under the direction of John B. Jervis, who succeeded Major Douglas as chief engineer in October, 1836. Water was passed through the aqueduct on June 27, 1842.

The population of New York City was then in the neighborhood of 375,000.

A. R. E. A. Annual Meeting Is Well Attended

Standardization and Labor Economics are Emphasized—Numerous Matters in 24 Reports Accepted

That labor economics is the coming great problem of the railway engineer as well as of industry in general was the opinion expressed in the presidential address of J. L. Campbell (El Paso & Southwestern Ry.) at the opening meeting of the 24th annual convention of the American Railway Engineering Association, held in Chicago, March 13-15. Mr. Campbell dwelt upon the difficulties of this problem as compared with physical problems. He believes that its solution lies in equal assimilation and practice of the principles of the Christian religion by both employers and employees. Development of standardization and especially the need of a wider use of adopted standards of design and practice were also dealt with by Mr. Campbell, who pointed out that there is a division of opinion in the Association as to whether it should continue its affiliation with the American Engineering Standards Committee, the adverse reasoning being that the railways constitute so large and distinctive an industry that they should make their own standards without entangling alliances. This matter came up later in the discussion of the report of committee on Standardization, which is composed of the chairmen of the several committees and which recommended close co-operation with the A. E. S. C. It was in part also the subject of a brief address by R. H. Aishton, president of the American Railway Association.

Committee Reports

Reports of the twenty-four committees had been printed in advance and aggregated nearly 1,100 pages. Every report was presented and acted upon, so that obviously there were few extended discussions, most of the matter being accepted formally by resolution. With the new edition of the "Manual" issued only recently there were comparatively few additions proposed, but all of these were adopted. The great bulk of the material in the reports was submitted as information and was accepted without dispute and with very little comment. In fact the action of the convention was mainly in stamping the work of the committees with the formal approval of the Association. The registration at the 1923 meeting totaled 665 members and 168 guests, as compared with 707 and 178 in 1922.

A memorial hour was set aside during one session for brief addresses paying tribute to the professional ability and high personal character of the late A. S. Baldwin (Illinois Central R.R.), C. E. Lindsay (New York Central R.R.) and William McNab (Grand Trunk Ry.) At the annual dinner the principal addresses were by Hon. F. B. Carvel, chief commissioner of the Board of Railway Commissioners of Canada; Floyd W. Parsons (formerly editor of *Coal Age*), and Judge Harry V. Osborne, president of the New Jersey Board of Public Utility Commissioners.

An increase of fifty in membership was shown by the report of the secretary. With ninety-six new members and the loss of forty-six members by death and resignation, the net membership on March 1, 1923, was 2,010, as compared with 1,960 in 1922.

Financial conditions were reported as being satisfactory, the receipts for 1922-1923 having been $45,280 or $3,283 in excess of expenditures, while the present cash assets amount to $45,025. The revised edition of the "Manual of Recommended Practice" was issued during the year. An amendment to the constitution which provides more flexibility in setting the date of the annual meeting was adopted by a ballot vote of 696 to 57 during 1922.

Excursions arranged for the day after the convention included inspection of the concrete investigation work of the Structural Materials Research Laboratory at Lewis Institute, fire tests of concrete at the Underwriters Laboratories and a visit to the Hawthorne works of the Western Electric Co. There was also a trip to the Forest Products Laboratory at the University of Wisconsin, Madison, Wis.

Officers elected for the year 1923-24 are as follows: President, Edward H. Lee, president and chief engineer, Chicago & Western Indiana R.R.; vice presidents, George J. Ray, chief engineer, Delaware, Lackawanna & Western R.R., and J. M. R. Fairbairn, chief engineer, Canadian Pacific Ry., the former holding over from 1922. The treasurer is G. H. Bremner, and the secretary E. H. Fritch, both being re-elected.

M., K. & T. Ry. Places Large Order for Water Softeners

As part of a move for providing better water for its locomotives a contract for twenty-four water softening plants has been placed by the Missouri, Kansas & Texas Ry. with the Graver Corporation, East Chicago, Ind. This order includes fourteen plants with a capacity of 5,000 gal. per hour, the others ranging from 8,000 to 30,000-gal. capacity. Two of the larger plants will have storage tanks of 100,000-gal. capacity. For proportioning the chemicals the weir type of device will be used, as the closer accuracy of the new submerged-orifice method of the Graver concern is not required for large water-softening plants.

New England Extension of Grand Trunk Certain

Only the failure of the Rhode Island General Assembly to grant a two-year extension of the charter permitting construction stands in the way now of completing the Southern New England extension from Palmer, Mass., to tidewater at Providence, of the Grand Trunk Ry. This announcement has been made by John S. Murdock, of Providence, vice-president of the Southern New England. As a result of such assurance, the floor leader in the Rhode Island House has introduced an act renewing the road's charter for two years. The extension is designed to link the Central Vermont, a subsidiary of the Grand Trunk, with deep water at Providence. The right-of-way is already largely graded. The road will run through one of the busiest industrial sections of the country. Work has been held in abeyance since 1912, original construction having been started in 1910.

Edward H. Lee Elected Head of Railroad Engineers

New President of A. R. E. A. Has Been Prominent in Development of Chicago Terminal Facilities

Edward H. Lee, elected president of the American Railway Engineering Association, is vice-president and chief engineer of the Chicago & Western Indiana R.R. Co. and the Belt Railway Co. of Chicago. These two lines form one of the most important passenger and freight terminal systems of Chicago and Mr. Lee has been prominent in the development of the city's railway terminal facilities.

Mr. Lee was born at Dayton, Ohio and was educated at the old Ohio University and the University of Wooster.

After working for several years on different railroads, some of which are now parts of the Baltimore & Ohio R.R. and Norfolk & Western R.R. he went to the Union Pacific R.R. and then to the Elgin, Joliet & Eastern Ry., of which he was office engineer and then chief engineer. Following this he had two or three years experience as partner in a contracting firm. In 1897 he returned to the railway field as chief engineer of the two companies mentioned above. Later he was made vice-president and during the war time period of government control of the railways he was president of both corporations, but resumed the combined position of vice-president and chief engineer when the railways were returned to their owners.

The design and construction of extensive track elevation work on lines of busy traffic was carried out under his direction, as well as the reconstruction of the great freight classification and transfer yard at Clearing, where the cars move by gravity and the yard switches are controlled from an elevated tower by electro-pneumatic apparatus. On the track elevation work Mr. Lee was a pioneer in the extensive use of machinery, including the use of unloader plows and spreaders in placing the great amount of sand filling, and the use of locomotive cranes for handling track material, raising temporary bridges and throwing track. He has advocated particularly the use of double-deck freight houses to economize high-value land areas, and the recent project for the reconstruction of the Dearborn Station of the Chicago & Western Indiana R.R. on a greatly enlarged scale was prepared under him.

Reservoir for Pennsylvania R.R. at Enola Yard

A 3,000,000-gal. reservoir formed by an earth embankment and lined with concrete is to be built by the Pennsylvania R.R. at the Enola yard on the low-grade freight line, just west of Harrisburg, Pa. Water will be pumped from the Susquehanna River to the reservoir, giving a gravity supply to the shops and yards. This increase in the water supply is part of a general plan to improve the facilities at Enola in order to insure more rapid handling of trains in fast freight service.

Additions to Water-Power Plants Are Authorized

California Developments Include Pit River, Caribou Extensions—Holtwood Station To Be Completed

Caribou Extension—Plans for the immediate installation of a third unit of 22,000-kw. capacity in the Caribou plant on the North Fork of the Feather River in California have been announced by J. B. Black, general manager of the Great Western Power Co. The addition to the generating capacity of the company will entail the expenditure of approximately $1,500,000. Surveying parties are already in the field and preliminary engineering work under way. Bids for hydraulic and electrical equipment will be called for within the next fifteen to thirty days. The installation will include penstock, turbine, generator, exciter, transformers and other electrical equipment. Tunnels and transmission lines are already completed. Increased load demands constitute the reason for the enlargement of the plant.

At the present rate of growth the added power will be required within a year and it is expected that the installation will be completed within that time. The present Caribou plant was placed in operation in the summer of 1901. The equipment includes two 30,000 horsepower double overhung impulse wheels operating under a head of 1,080 ft. and two 11,000-v. 22,223 kva. generators. The ultimate capacity of the plant is six such units.

Skagit River Development—Bids for the construction of 100 miles of 165,000-v. transmission line and telephone line from the Gorge Creek plant of the Skagit River development to the city of Seattle will be called for April 13 according to C. F. Uhden, chief engineer of the project. Specifications will be completed by Mar. 30 and will be on file in the office of the chief engineer, 1400 Alaska Building, Seattle. The line will bring power from the Gorge Creek plant, the first unit of Seattle's municipal development program on the Skagit River, to a substation outside the city. The plant, which will have an initial capacity of 34,500 kw., will be completed late in 1923. It is planned to have the transmission line ready for operation at the same time.

Holtwood Station—Completion of the Holtwood (McCall Ferry) power station, on the Susquehanna River, of the Pennsylvania Water & Power Co., delayed almost ten years by the war, is finally to be brought about. A contract has been given the I. P. Morris department of the William Cramp & Sons' Ship & Engine Building Co. for the remaining hydraulic machinery needed, principally consisting of two 20,000 hp. Francis turbines of the I. P. Morris design.

The addition of this equipment will bring the station up from 110,000 to 150,000 hp. capacity, for which it was originally planned. The present hydraulic equipment consists of eight turbines, all of I. P. Morris design and construction, but the two new wheels will not only be much larger and more powerful than any of the older ones, but the delay has enabled the Cramp company to embody in them a number of the latest improvements, evolved since the original installation was made, in design of draft tubes, etc., which will result in increased efficiency of the station as a whole.

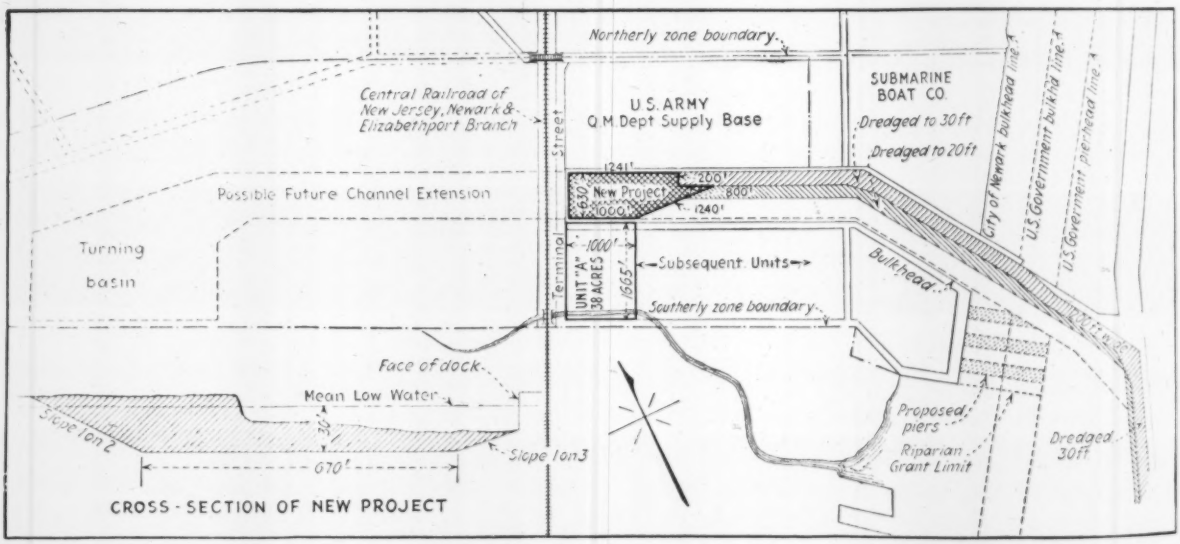
The Holtwood station operates on an average effective head of 54 ft., the concrete dam being 55 ft. in height and half a mile long. The present battery of generators is of the three-phase, 25-cycle type, with 11,000 voltage at the generator terminals. This is stepped up by transformers to 70,000 volts in the long-distance transmission lines.

The two new turbines are by no means the largest which the Cramp company now has on hand. Work is now approaching completion on the two 70,000 hp. Francis turbines for Niagara Falls in the Cramp I. P. Morris shops. These will be, when installed, the most powerful hydraulic turbines ever constructed.

Pit Number 3—Construction of Pit Number 3, the second of a chain of power houses which will ultimately develop over 600,000 hp. from the waters of the Pit River in Northern California, will start within the next thirty days according to an announcement made by John A. Britton, vice-president and general manager of the Pacific Gas and Electric Co. The plant will have a capacity of three 27,000 kva. units and will be completed by the fall of 1925. The development will involve a cost of about $17,000,000.

Pit Number 3 will be located about twelve miles below Pit Number 1 power house. Installation will involve the construction of a diversion dam 125 ft. high at a point two and one half miles below Pecks Bridge on the highway between Burney and Bartle. From this point a tunnel approximately 22,000 ft. in length, having a capacity of 3,000 sec-ft., will carry the water to a point above the site of the power house. The plant will operate under a static head of 313 ft.

City of Newark Extends Port Terminal Development



Under contracts recently awarded, the Department of Streets and Public Improvements of the City of Newark is extending the Port Newark terminal development. The channel from the government project in Newark Bay as far as the western pierhead line of the bay has been dredged to 30 ft. by the federal government. From this line to the crossing of the Central R. R. of New Jersey the work is in the hands of the Port Newark administration. The first dredging that was done in this section provided for a width of 400 ft. and a depth of 21 ft. Later the northerly half of this channel was deepened to 30 ft. and 7,000 ft. of marginal dock was built.

The present project is to widen the channel to 670 ft. beginning at its west end, alongside the Central R. R. of New Jersey, and extending for 1,200 ft. eastward; and to deepen it to be 30 ft. for the full width. This will involve about 525,000 cu.yd. of dredging which is being carried on by the Atlantic, Gulf & Pacific Co. of New York. A contract for 1,000 ft. of dock-wall has been awarded to Allen Spooner & Sons, Inc.

The initial step in the development will be the construction of an extension of the Pit River R.R. The line will branch off at Cayton Valley and will follow the river in a southwesterly direction, a distance of five miles to the dam site. The road will then extend five miles further to the site of the power house. A gravity road will lower the material to the construction camp at the dam site before work on the permanent dam is started. A temporary diversion dam and tunnel will be constructed. The driving of the four-mile turn will start immediately. The installation will also require the construction of eight miles or more of double circuit 220-kv. transmission line from power house number three to the main transmission system.

Another Hearing on Carquinez Strait Bridge Held

A public hearing was held in San Francisco March 6 before Major U. S. Grant, III, Engineer Corps, U. S. A., to receive the application of the Rodeo-Vallejo Ferry Co. for permission to build a bridge, in accordance with the franchise recently secured from Contra Costa County, and to hear any objections or protests.

The Rodeo-Vallejo Ferry Co. has secured the approval of the California State Engineer and holds a franchise from the supervisors of Contra Costa County to build a bridge across Carquinez Strait from Valona to Morrow Cove, provided construction is begun before June 5, 1923 and completed within three years. A previous hearing before army engineers was held on this project and was reported in *Engineering News-Record* Nov. 30, 1922, p. 949. The March 6 hearing was made necessary by changes in plans made to conform to restrictions imposed by the franchise, and because of the desire of the Rodeo-Vallejo Ferry Co. to submit to the War Department two alternative plans, one for a cantilever and the other for a suspension bridge, either of which would meet the requirements of the franchise as granted by Contra Costa County.

The cantilever bridge would require a pier centrally located in the Strait but would leave a clear channel on either side of the central pier 1,070 ft. wide. Two other piers would be within the pier head lines and each would be reached by a 500-ft. approach anchor-span. The suspension design calls for a 1,950-ft. center span with two approach spans of 975 ft. each.

The applicant asks that approval be granted for either type of bridge, thus making it possible to call for competitive bids on both types. However, if the War Department can give approval on only one type, preference was expressed for the cantilever structure because of its lower cost. Admiral J. S. McKean, Commandant of Mare Island Navy Yard, stated that neither type of bridge would be a menace to navigation and that while the center pier might be considered an obstruction, the disadvantage of having a central pier was more than offset by getting the two shore piers inside the pier head lines.

Charles Derleth, Jr., is chief engineer of the Rodeo-Vallejo Ferry Co. and Wm. H. Burr of New York City is consulting engineer.

Eugene Young A.G.C. Secretary

Eugene Young, formerly secretary of the Minneapolis Builders Exchange, has been appointed secretary of the Associated General Contractors of America. He takes the place of G. W. Buchholz, who recently resigned to enter the contracting field. In the selection of Mr. Young, the Association has obtained a man well qualified to assume the duties of such an office. His success in organization work, and in dealing with labor problems in Minnesota is well known in construction circles; and as a monument to his executive ability he left the Builders Exchange a membership of 380, a modern 12-story office building, and a surplus in its treasury.

Engineering Employment Still on the Up-Grade

Engineering services continue to be in demand in most sections of the country, but particularly in the Middle West. The outlook for technical employment is active and favorable, reports the employment department of the American Association of Engineers which outlines the situation as follows:

The past six months have been exceptionally good for the office engineer and the expert engineer. This demand is expected to continue for some time. The number of plans being prepared indicates an up-tone of strength and a large demand for construction engineers and estimators, provided construction does not reach its limit in labor supply and material.

Engineering activities are starting to show signs of life in the northwest section where weather conditions have caused a general pause. Building, municipal construction and road work are starting, with manufacturing coming along strong. In California engineering work continues good. The southwest section has been poor for the civil engineer but excellent for the miner. The mountain states show an early spring start with a number of oil, mining and general engineering projects under way. The central states have on hand a large volume of construction work, much of which is being rushed to completion and much new work being started. The coal mining region indicates continued activity with a fair demand for technical services from that section. Engineering work is not as active in the eastern states, particularly in New York and Massachusetts, and business is not as optimistic, although the supply and demand for engineers about balances. The following table shows the trend of employment for the whole country:

	Jan., 1923	Dec., 1922	Jan., 1922
Applicants for employment..	1,256	1,018	1,872
Positions received.....	536	462	323
Men referred.....	1,123	666	1,428
Men placed.....	149	105	156

The average salary of positions filled was $195 a month.

New York Railroad Club Discusses National Transportation

At a meeting of the New York Railroad Club held in that city on March 16, J. Rowland Bibbins, consulting engineer and formerly manager of the department of transportation of the Chamber of Commerce of the United States, presented a paper on "Our National Transportation System." Mr. Bibbins outlined the development of the several transportation agencies and emphasized the need for a better integration of the railroads, highways and waterways in the interest of more efficient transportation service to industry. As a beginning he urged the intensive study of the several metropolitan areas of congestion.

The paper was discussed by Capt. S. B. Moore, consulting engineer; Col. Willard Chevalier, *Engineering News-Record*; D. L. Turner, consulting engineer, New York Transit Commission; Col. H. D. Emerson, consulting engineer; Col. Charles Hine, consulting engineer; J. C. Lincoln, traffic manager, New York Merchant's Association; W. E. Symons, mechanical engineer; J. Shirley Eaton, consulting engineer and J. S. Marvin of the National Automobile Chamber of Commerce.

Railway Revenues Increased During 1922

According to a recent bulletin issued by the Bureau of Railway Economics, the total operating revenues of Class 1 railways and large switching and terminal companies in the United States, in 1922 amounted to $5,617,252,656. This compares with $5,573,153,133 in 1921, representing an increase of 0.8 per cent. The total operating expenses amounted to $4,455,650,216 for 1922. This is a decrease over 1921 of 3.2 per cent. The net railway operating income amounted to $776,665,960, or an increase over 1921 of 26 per cent.

Engineering Foundation Elects Officers at Annual Meeting

At the annual meeting of the board of Engineering Foundation Charles F. Rand, treasurer and past president of the American Institute of Mining and Metallurgical Engineers, was re-elected chairman, and Edward Dean Adams of New York, fellow of the American Society of Civil Engineers, was chosen first vice-chairman. Frank B. Jewett, president of the American Institute of Electrical Engineers, was elected second vice-president, and Alfred D. Flinn was re-elected director. Joseph Struthers is treasurer and Henry A. Lardner, assistant treasurer. Dr. W. F. M. Goss, president of the Railway Car Manufacturers Association, was elected to the foundation board to succeed George M. Basford, and Col. Arthur S. Dwight was chosen to succeed Edwin Ludlow. Other members of the board for the coming year are George H. Pegram, Bancroft Gherardi, Silas H. Woodard, Prof. Arthur L. Walker, John H. Barr, H. Hobart Porter, Dr. David S. Jacobus, Prof. Herbert M. Boylston, E. Wilbur Rice, Jr., Elmer A. Sperry, and J. Vipond Davies, president of the United Engineering Society. The executive committee consists of Messrs. Rand, Adams, Pegram, Jewett and Porter.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Norfolk, Va., May 7-9.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Spring Meeting, New Orleans, La., April 18-20.

NATIONAL FIRE PROTECTION ASSOCIATION; Boston; Annual Meeting, Chicago, May 8-10.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Detroit, Mich., May 21-25.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29 or 30.

The Rochester Engineering Society will be host to the New York Section of the American Water Works Association at its last meeting of the year, in Rochester, Apr. 7. The address of the principal speaker, Alvin H. Dewey, manager of the Rochester & Ontario Water Co., will be followed by an inspection of buildings and equipment of the Rochester repair department and yards. The speaker at the banquet in the evening will be Dr. Samuel W. Stratton, president of Massachusetts Institute of Technology.

Personal Notes

WILLIAM R. CASEY, formerly civil engineer with A. E. Stephens Co., Springfield, Mass., has become associated with McClintock & Craig, engineers and architects, of that city.

C. I. RHODES, chief hydraulic engineer for the California State Railroad Commission, has resigned to enter private practice as consulting engineer in association with C. H. LOVELAND, of San Francisco. Mr. Rhodes has been with the commission for five years, for the past two years holding the position of chief of the hydraulic division.

F. W. EPPS, for the past five years bridge engineer of the Kansas Highway Commission, has resigned and entered consulting bridge and road engineering with H. S. MCFADDEN, under the firm name of the Kansas Engineering Co. This firm has been doing road work in Kansas for the past four years. Mr. Epps is secretary of the Kansas Section of the American Society of Civil Engineers, a member of the executive committee of the Kansas Engineering Society, and president of the Topeka Engineers Club.

ALFRED H. TERRY, formerly city engineer of Bridgeport, Conn., and also engineer during the war for the United States Housing Corp., was elected president of the Connecticut Society of Civil Engineers at the annual meeting held recently at Hartford.

EDWARD BURR, who recently retired from the Corps of Engineers with the rank of colonel and who served with rank of brigadier-general during the World War in France, has been retained as one of the consultants on the staff of the chief engineer of the Board of Estimate and Apportionment, New York City, in connection with the Narrows Tunnel project. General Burr retired Feb. 22, being at that time U. S. District Engineer in charge of the First District, New York City, a station which he had held since his return from France. During his term of service in New York City, he was in charge of river and harbor improvements, including all federal matters in New York Harbor east of the Jersey state line. These improvements aggregated a total estimated cost exceeding $50,000,000 and included operations for moving all classes of material from harbor mud to ledge rock. Previous to the World War, General Burr was senior assistant to the Chief of Engineers and was acting chief of engineers for periods totaling ten months.

ISADORE WALZER, former county assistant engineer of Nassau County, New York, for the state highway commission, has resigned to accept a position as secretary and treasurer of the newly-organized Heling Construction Corp., engineers and contractors of Lindenhurst, L. I.

LAWRENCE W. COX has resigned as assistant city engineer of Dubuque, Iowa, to become city manager of Maywood.

L. D. PARKS, until recently county engineer of Comanche and Erath Counties, has been appointed county engineer of Eastland County, at Eastland, Texas, succeeding W. R. Eccles, resigned. Mr. Parks is a graduate of Texas A & M College. He was assistant sewer engineer of the City of Houston prior to the war, during which he served as an officer in the air service.

L. O. FORSGARD has resigned as city engineer of Palestine, Texas, to become city engineer of Nacogdoches. Mr. Forsgard is a graduate of Texas A & M College and was formerly assistant engineer with the City of Houston.

REEDS & THORPE, engineers of Hartford, Conn., have dissolved partnership, Mr. Reeds retiring. GEORGE H. THORPE will continue the business under his own name.

ALVIN G. ANDREW was elected as borough engineer for Tyrone at a meeting of the council, succeeding the late R. A. ZENTMYER.. Mr. Andrew was formerly associated with the Pennsylvania R.R. Co. as assistant supervisor of the Tyrone division.

DONALD DES GRANGES, formerly with Cram & Ferguson, Boston architects, has joined the organization of Stone & Webster, Inc., of Boston, as engineer in the structural division. During the war Mr. des Granges was engaged in architectural work in France on the development of the port of St. Nazaire and other A. E. F. operations.

WALKER B. LOUNSBERRY, of Binghamton, N. Y., has been appointed as assistant city engineer of that city by W. Earl Weller, the city engineer.

ARTHUR RICHARDS, Columbus, Ohio, has been chosen city engineer of Chillicothe. He is a graduate of Ohio State University, department of civil engineering, and following his graduation was employed by the city of Columbus for several years. He then went to the Panama Canal where he was employed for six years on construction work. Since 1918 he has been bridge engineer of Franklin County, Ohio. Mr. Richards succeeds HENRY M. REDD, who resigned recently.

FRED GRUMM has been appointed office engineer in the headquarters office of the California State Highway Commission at Sacramento. Mr. Grumm goes to Sacramento from the Fresno office where he has been located recently as assistant division engineer.

R. W. HEBARD, member of the firm of R. W. Hebard & Co., Inc., engineers and contractors of New York, has been elected a director of the International Railways of Central America. The International Railways comprise the existing railway mileage in the Republics of Guatemala and Salvador.

C. V. WADDINGTON, engineer for the Kansas Gas and Electric Co., Wichita, Kansas, has been appointed secretary and treasurer of the Kansas Engineering Society to fill the vacancy made by the resignation of C. P. BUCK of Topeka.

F. B. GOEDIKE, has been appointed engineer for York Township, including a large suburban area of Toronto. Mr. Goedike is a graduate of Queen's University, Kingston, and has had an extensive experience in railroad, harbor and waterworks construction.

ARTHUR V. MONINGER, formerly chief engineer with Donaldson and Meier, architects, Detroit, Mich., has joined the staff of the Federal Bond and Mortgage Co., of Detroit, as construction manager. Mr. Moninger has spent considerable time in contractors' organizations and in his new position will have supervision over the construction of a large variety of building projects.

Obituary

JOHN FARRELL, for 70 years a contractor in Montreal, died Mar. 16, aged 96. He constructed the two original gas works in Montreal and remained active in business until a few years ago.

DAVID DEXTER CLARKE, former chief engineer of the Water Bureau of Portland, Ore., died recently, aged 79 years. Mr. Clarke, who was born in South Hadley Falls, Mass., went to Portland in 1864 and took up immediately the practice of civil engineering. Several years later he was engaged in government surveying work in Washington State, but returned to Portland and became assistant to the chief engineer of the Portland Water Bureau. In 1917 he retired from active service, though he maintained almost daily touch with water bureau officials until a month before his death.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Railway Appliances Shown at Chicago Exhibit

Development of Small Tools Indicated—Train-Control Systems Displayed at Coliseum Last Week

(Engineering News-Record Staff Report)

RAILWAY work is promising so wide a field for the near future that the annual National Railway Appliances Exhibition, held at Chicago in connection with the convention of the American Railway Engineering Association, March 13-15, was of more practical interest than it has been for the past few years. Although the exhibits were fewer in number than in some previous years they lacked little in comprehensiveness, the reduction being mainly in the number of individual exhibits of different classes rather than in the classes themselves. There were more than 160 exhibits at the Coliseum, but some firms which usually exhibit were content this year to have representatives in attendance at the convention at the Congress Hotel. Novel or special features in the products on display were rare, the exhibits, with few exceptions, being standard or well established materials, devices and appliances.

Track and Track Appliances

Rails, frogs and switches were notably limited and only well-known rail joints were included, the usual experimental joints being absent. Switchstands were numerous and there were some special frog guard-rails, including ordinary and manganese steel rails, cast-steel guards of the American Chain Co. and a "girder" guard, consisting of a heavy bar supported in chairs, of the Positive Rail Anchor Co. Bumping posts were also in evidence. Such smaller appliances as spikes, bolts, washers, tie-plates and rail anchors were fairly numerous.

Track Machinery and Tools

There were only a few of the machines for heavy work, such as steam shovels, ditchers, spreader cars, locomotive cranes and weed-killing (chemical) cars. They were represented mainly by models and drawings. A notable exception was a Koehring concrete mixer mounted on flanged wheels and intended for miscellaneous scattered or isolated railway jobs requiring amounts of concrete too small for regular work-train service. Ballast-tamping machines were displayed, both electric and pneumatic tampers requiring traveling power or compressor outfits.

Smaller tools and mechanical appliances were in much greater number and it appears that it is in this class of appliances that greater development may be expected. They included small portable hoists for laying rails, a tie-spacing device, the Owen tie-puller for renewing ties, ballast cleaners, track-lining jacks of the Rail Joint Co. and the Idol Co., a Q. & C. snow melter for use at switches, an Ingersoll-Rand rail drill, and the Rawls and Woolery mowers attached to motor cars. The number and variety of motor cars for section and bridge gangs was very large. Hand tools for track work were numerous, including the Wood Co.'s shovels of molybdenum steel.

Engine Terminals and Shops

Exhibits in the engine terminal and shop class were much less numerous than usual, particularly in regard to railway buildings. Models represented an Ogle reversible-hoist coaling station and a new design of Roberts & Schaefer ash-pit with mechanically operated car receiving the ashes and traveling up an inclined track to discharge into an ash car. Several water columns and oil columns were exhibited; also an oil-engine centrifugal pump, windmill pumps and water-softening plants. Wood and steel elevated tanks were represented and the Chicago Bridge & Iron Works showed a self-supporting steel dome roof on tanks. For enginehouse work there were smokejacks and ventilators and a Nichols electric tractor for turntables. Prominent among building materials were the zinc shingles and corrugated sheeting of the Illinois Zinc Co.; other exhibits in this line included wood-block flooring and asbestos and asphalt shingles.

Three or four makes of steel fence-posts were shown. Highway crossing signals were numerous, with both flashing and revolving lights. A crossing with Headley bituminous macadam paving was shown as an improvement upon ordinary planking, and there were two unusual, but little used, types of cattle guards, one of these being composed of rollers.

Bridges and Structures

Practically the only bridge exhibits were the Raymond cast-in-place piles and the Massey precast concrete piles and slab spans for bridge and trestle decks. Others of the few exhibits included concrete cribbing for retaining walls, culverts of corrugated iron pipe, concrete pipe and cast-iron sections.

In the miscellaneous class may be listed the Clark dump-car, several torch welding and cutting devices, leadized pipe, chemical toilets, two or three weed-killers and different makes of industrial motor trucks for shop and factory use. Signals were less numerous than usual and most of them used lights instead of semaphores. On the other hand, there were four or five automatic train-control systems.

New Officers Elected

At the annual meeting of the Nation Railway Appliances Association officers were elected as follows: President, L. W. Shugg, General Electric Co., Schenectady, N. Y.; vice-president, A. J. Filkins, Paul Dickinson Co., Chicago; secretary, C. W. Kelly, Kelly-Derby Co., Chicago.

Should Equipment Makers Feature Record Runs?

Figures for Unusual Performances Are Subject to Misconstruction by Engineers and Contractors

By K. H. Talbot

Koehring Co., Milwaukee, Wis.

There has long existed a considerable diversity of opinion among manufacturers of construction equipment and materials as to the advisability of attempting to capitalize record performances. While temporary advantages may be secured by featuring unusual runs, it is open to question whether this practice, in the end, benefits either the maker or the user of construction machinery.

The Koehring Co., of Milwaukee, manufacturers of concrete mixers, locomotive cranes and rotary graders, has established a definite policy on this subject which is set forth in the following statement.—Editor.

AS TO the desirability of presenting record runs in advertisements and in articles for publication, the Koehring Co. has always felt that it is a mistake to use any language in its advertising that gives a wrong impression to any one, whether or not he be familiar with the machine advertised. The policy of this organization, therefore, is to use nothing in its advertising that, however construed, would be detrimental to the construction industry. Figures on record runs made with machines over short periods of time are misleading as to the amount of work that can be completed in a year.

To the uninitiated, and even to the engineer and road official who are not conversant with the actual quantity of concrete that can be laid with a contractor's organization, the publishing of such information leads to conclusions as to the quantity that can be placed *per year*. The tendency is to feel that there must be a considerable discrepancy between the effectiveness of the contractors' organization on work in their own vicinity and that in some other part of the country.

With machines of the size that are now being generally adopted the receiving, handling and transportation of the material requires organization. A highway represents the labor and equipment required to handle this part of the work as well as the labor and material required to mix and place the concrete. Conditions may arise where economy dictates the desirability of carrying a heavy payroll expense to drive the machine at its utmost capacity throughout the whole construction season, and there may be conditions, over which the contractor has no control, that reduce the amount of material that can be economically delivered to the machine.

It is not possible for the manufacturer of construction equipment to know the conditions surrounding the individual construction jobs, nor should he furnish information that may be used as a means of arriving at an average figure for work, based on maximum runs over short periods. This last statement is in line with the policy adopted by this company four years ago, namely, to offer to contractors all information

possible to assist in obtaining the utmost from the equipment manufactured by us. We have always differentiated between the service that should be given by a manufacturer of equipment and the service that should be given by a consulting engineer. In other words, a manufacturing company may offer to a contractor a suggestion based on past experience but it cannot take the responsibility of furnishing figures on which an estimate of cost can be based.

[*In next week's issue other manufacturers will discuss their policies on featuring record runs or performances.* —EDITOR.]

Hoover Commends Progress in Lumber Standardization

W. A. Durgin, chief, Division of Simplified Practice, U. S. Department of Commerce, who was delegated to represent Secretary Hoover at the annual convention of the Southern Pine Association and the National Lumber Manufacturers' Association at New Orleans, at the end of his own speech on lumber standardization March 20, read a message from Mr. Hoover, from which the following is quoted:

"The better part of a year has passed since the representatives of your interests and all other lumber interests met with us in the Department of Commerce to initiate plans for coordinated voluntary action for national simplification and standardization of sizes and qualities of lumber and the development of suitable machinery within the trade to secure their observance. During these ten months a substantial organization, heading up in your Central Lumber Committee and the consulting committee of technical experts, has been developed, and I am informed that progress has been made toward adjusting the viewpoints of various sections of the country and formulating standards which shall have nationwide acceptance.

"Most of the earlier obstacles appear to be safely past. With the exception of one group which persists in misrepresenting the motives and objects of our common undertaking, I think all lumber interests are agreed on the fundamental importance of these plans, not only in themselves and for their immediate benefit to lumber producers and distributors, but because of the convincing demonstration they will carry of the intent of you lumbermen to place your business on a plane of highest business ethics and widest national service.

"The far-reaching economies in transportation and construction, the elimination of waste of our forest resources, the better protection to the consumer, the better understanding of the quality of American business men, are all great objects to be attained.

"I have stated repeatedly that my only thought in these undertakings is to make the Department of Commerce of value in cooperation for measures which must be carried out through the machinery of the trade itself, as a matter of self-government in the trade. I am uttterly opposed to any attempt to extend the arm of government, but I am equally convinced that these questions, so vital to the stability of our national industrial fabric, can gain great weight through proper Government support to the efforts of the trades."

Motor Industry Registers Third Largest Month

February motor-vehicle production was the third largest month on record, according to shipping reports made March 7 to the directors' meeting of the National Automobile Chamber of Commerce in New York City. The output of 270,995 cars and trucks is regarded by the industry as indicative of a big year, as February is usually a light period. The production figure for the past month is 125 per cent greater than the second month in 1921.

The previous high mark for February was 180,000 in 1920.

The production figures for the three record months are: 289,011 in June, 1922; 272,538 in August, 1922; and 270,995 in February, 1923.

Contractors' Graveyards

Discussion by Alfred Carlson, Seattle, Wash., at the convention of the Associated General Contractors at Los Angeles, Jan. 30-Feb. 3.

A. P. Greensfelder's report for the Committee on Methods might be enlarged with regard to equipment waste. Going through the country you see the carelessness that many farmers show in the care of their equipment. On every farm I passed here or elsewhere, and over the country, the machinery stands outside. When the farmer finishes his work, he dumps his machinery on the nearest acre lot that he doesn't want to use—puts it there with no shed, and there it stands and rusts.

That practice is true, also, of contractors. Go through your cities and villages to the contractors' equipment yards and see how their equipment looks. I call them the contractor's graveyards. There stand concrete mixers that had been used and left full of concrete. They look as if they have been immersed in concrete and left there to stand, representing a loss of thousands of dollars.

You never find a contractor's warehouse; you can't find a single thing. I think one of the greatest losses is that due to carelessness of the contractor and his crew. When they are through with a job, they slam the equipment on the truck and get it back into the yard and it is there in a heap and nobody cares for it. When you want a ten-cent tool, you take a dollar of time to find it.

It is left to the superintendent or purchasing agent to order equipment and he orders equipment you can't use.

Discuss Uniform Motor Parts

Wider adoption of standards in automobile and motor truck construction, with particular regard to uniform sizes for certain parts, were discussed March 9 at a meeting of representatives of various interested associations called by the Division of Simplified Practice of the U. S. Department of Commerce. A central committee was created to carry out a program of standardization. The first subjects to be considered will be spark plugs, roller bearings, storage batteries and tires.

Business Notes

TRUSCON STEEL CO., Youngstown, Ohio, announces that F. H. Maloney was appointed Feb. 15 general agent for its railroad department, covering the southwest territory, with headquarters at St. Louis.

GIBB INSTRUMENT CO., Bay City, Mich., manufacturer of electric welding equipment, has opened a sales office in the General Motors Building, Detroit, in charge of F. M. Luchs, formerly chief engineer for the company.

EASTERN FOUNDRY CO., Boyertown, Pa., has recently been organized for the manufacture of cast-iron soil pipe, fittings and plumbing specialties. For its personnel the new organization has drawn largely upon the Sanitary Co. of America, the controlling interest in which has been disposed of by E. M. Rhoads who heads the new organization with the title of president and treasurer. The other officers of the Eastern Foundry Co., all former members of the Sanitary Co., are B. W. Frederick, vice-president; Grant P. Bechtel, secretary; Daniel G. Burkert, purchasing agent; and Harry R. Trout, general superintendent.

A. E. ENSTELL, formerly with the Equipment Corporation of America, has established a business of his own at 1628 Market St., Philadelphia, for the purchase, sale or rental of new and used contractors equipment.

MORRISON & RISMAN CO., INC., Buffalo, N. Y., manufacturers and jobbers in railway track equipment, has been incorporated, with a capital of $500,000 fully paid in. The officers of the company are: S. Morrison, president; S. Risman, vice-president; R. L. Morrison, treasurer; and S. H. Risman, secretary. The company maintains general offices in Buffalo, N. Y., district sales office in Philadelphia, and has works and warehouses in East Buffalo, N. Y., and Lebanon, Pa.

DODGE SALES & ENGINEERING CO., Mishawaka, Ind., which for the past eight years has been operating as the selling subsidiary of the Dodge Manufacturing Co. and the Dodge Steel Pulley Corp., has been consolidated with the parent company, the Dodge Manufacturing Corp., organized last July. The distribution of Dodge products, including power transmission appliances and heavy oil engines, will be conducted by the sales department of the Dodge corporation, with Duncan J. Campbell, general sales manager in charge, and John A. Beynon, assistant general sales manager. Activities of the advertising department, under the direction of William W. French, include a complete program of dealer co-operation.

DETROIT STEEL PRODUCTS CO. has opened a branch office, in charge of C. W. Moon, at 22 North 5th St., Reading, Pa., to better serve the architects and engineers in central Pennsylvania. Mr. Moon has been connected with the company for seven years as sales engineer.

Equipment and Materials

Portable Compressor Designed for Road Building and Other Uses

For breaking pavements with air-operated drills and for other uses, such as erection of structural steel and work incidental to trenching and pipe-laying,

the Buhl Co., Chicago, has developed a portable compressor weighing 2,700 lb. and having a capacity of 80 cu. ft. of free air per minute. It is mounted on a four-wheel steel-channel frame, is driven by a 16-hp. gasoline engine, and has overall dimensions as follows: Width, 66 in., length, 105 in., and height, 70 in.

The air receiver, mounted on the front of the truck, is a cylinder 24 in. in diameter and 42 in. high. Cooling of the gas engine and compressor water is accomplished by a radiator and a belt-driven fan. One of the features of this outfit emphasized by its manufacturers is the use of mechanical four-speed oilers which pump fresh oil to all main and connecting-rod bearings and to cylinders. The governor is of the positive gear-driven, built-in type, and the compressor unloader is positive in its operation.

Variable Weight Grab Bucket for Rehandling and Excavating

Designed for both rehandling and excavation, the new Universal grab bucket (Type W) designed by the Mead-Morrison Manufacturing Co.,

Boston, in sizes ranging from ½ to 2 cu. yd. has a variety of uses. To secure the maximum bite at closing the hinge-shaft and the pivot point of the yokes and links are off center. This feature, the manufacturers claim, increases the closing leverage, so that the bucket does not lift but stays where it drops and digs down.

For different services the bucket is equipped with removable counterweights on the lever arm, while the purchase at the sheaves may be changed at will to either 2, 3, 4 or 5-part arrangement, according to the job at hand. Experience shows that the bucket rehandles best with two or three-purchase reeving and no weight, while excavating takes four or five-purchase reeving with two-thirds of the weights in place.

Another feature of the design allows the shell to be renewed in the field. The usual arrangement of hinges and stiffener is modified so that they are connected to form a framework to which the shells are bolted and may be disconnected without disconnecting any other part of the grab. For excavating in hard pack material removable cast-steel teeth may be bolted to the cutting edges.

Make Stronger Rope By Replacing Inner Yarns with Fibre Core

By a new form of Manila rope structure, increased strength and durability are secured in the larger sizes—above 1 in. diameter. The new rope, a prod-

CORE OF UNSPUN HEMP (BELOW) REPLACES TWISTED YARNS (TOP)

uct of the Whitlock Cordage Co., New York City, differs from other types in that the inside yarns have been replaced by a core of unspun hemp, protected by a sheath of outside yarns. This new-process rope has been given the name Fibore. It is the invention of Herbert V. Whitlock and is covered by basic patents.

In the ordinary type of rope (excepting the smaller sizes) the strands are made up of layers of yarns twisted around one another. When rope of this sort is subjected to tensional stress the yarns do not pull as a unit, but rupture successively, layer by layer, beginning with the inner yarns. These center yarns, forming a helix of the same pitch but of smaller diameter than the outer yarns, have a shorter length and are therefore first stressed to this limit of strength.

With the Fibore rope, however, the forces act differently, all of the straight inside fibres composing the core being subjected to a uniform pull. This type of rope structure, it is claimed, adds from 10 to 30 per cent to the strength of the rope and increases durability, inasmuch as all friction occurs between fibres essentially parallel to each other and not between yarn rubbed against yarn. Other advantages mentioned by the manufacturer are easier handling due to great flexibility, less permanent stretch and greater elasticity. Splicing is accomplished in practically the same way as when using ordinary rope. In making "tapered" splices, or long transmission splices, division of the fibre core is made in the same manner as when separating the usual center yarns.

Publications from the Construction Industry

Cement Prices and Profits—CEMENT INFORMATION SERVICE, New York City, has published a 15-page pamphlet entitled "Concerning Cement." The material is an answer, from the cement manufacturer's point of view, to charges which, according to the foreword, are unfounded and have affected the relations between the cement industry and the public. The subject matter includes prices, profits, competition, production, and construction cost.

Leaning Wheel Graders—J. D. ADAMS & Co., Indianapolis, in a 56-page illustrated booklet sets forth the application of its leaning-wheel graders to road construction. A back-sloper attachment may be employed on the graders for cutting ditches. The leaning-wheel feature balances the weight of the machine against the side load of earth on the blade, the angle of inclination of the wheels being adjustable. The booklet describes in detail the construction and adjustment of these graders, which are made in a number of sizes, the largest being the Road King No. 12, with a 12-ft. blade for tractors of 25 drawbar horse-power or more. The illustrations are well selected and show the application of the graders and back-sloper attachment to a wide variety of work. Other types of equipment, including scarifier attachment, road maintainers or drags, scrapers, plows, and wheeled scrapers are described.

River Bank Protection — Woods Bros. Construction Co., Lincoln, Neb., has published a 32-p. illustrated booklet on the practical application, by means of standard current retards, of the principle of sedimentation to the replacement, protection and conservation of river banks subjected to erosion, wash or cutting. The methods described involve the use of the Bignell pile as a permanent submerged anchorage for the retards. These piles are reinforced-concrete columns 14 in. square and 20 ft. long with a 4-in. pipe running through the center to which, at intervals, are connected small pipe jets with upturned ends. Water at from 150 to 200 lb. per square inch pressure is forced through the central pipe openings and the side jets to sink the pile. The retards consist of mats of trees larger than 8 in. in diameter at the butt that are anchored by cables to the piles. The booklet describes the processes of construction in detail, while sketches and photographs illustrate the sequence of operations. There is also a section describing the action caused by the completed retards. This system of river bank protection, it is claimed, has been responsible for saving large areas of valuable farm land.

Business Side of Construction

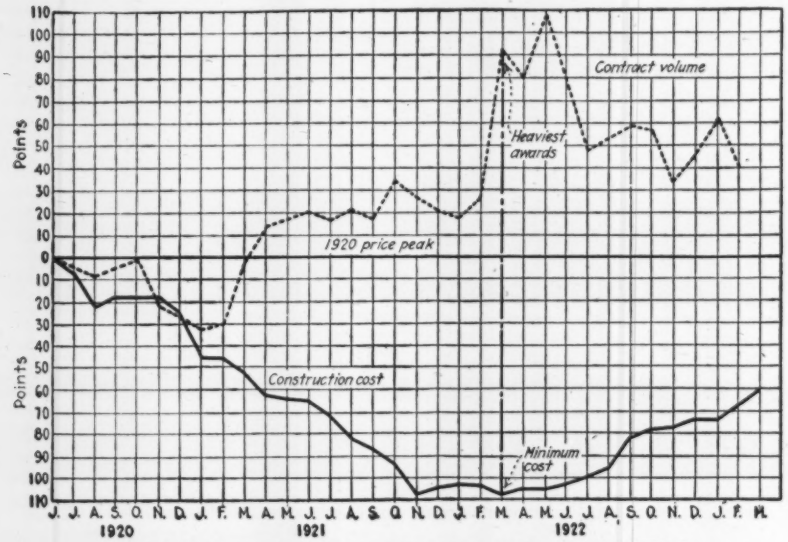
FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Reasonable Prices Will Make 1923 a Banner Year

Falling Prices of 1921 Produced Heavy Construction of 1922—Cost Is Higher Than 1921 Average

Decline from the record prices of 1920 began in November of that year, and proceeded steadily until December, 1921. The cost curve then remained fairly flat for the next six months, the long upward swing (which still continues) starting with June, 1922. The rise is 43 points.

Construction volume reacted very favorably to the falling prices in the latter half of 1920 and throughout 1921. Cost to build had become so great by June, 1920, (the peak), that eight months of falling prices elapsed before the volume of construction equaled the 1913 volume. The very next month, March, 1922, contracts were awarded at the rate of more than 60 per cent above the 1913 rate. April was 50 per cent above 1913, and May reached the maximum of 79 per cent.



HOW FALLING PRICES STIMULATE CONTRACT LETTING

With this prospective record demand, began the cost rise which now is viewed with gravity by far-seeing men in the industry.

The *E. N.-R* Cost Index averaged 201.78 for 1921, when the Volume Index was only 88. The Cost Index is now 205.25. True, contract volume holds above the pre-war rate, and March promises to be a record month. Somewhere, however, there is a breaking-point, where the volume curve will bend downward and remain low for a long while despite possible thirteenth-hour efforts to stimulate business.

At present, demand is good, and 1923 may boom along despite the increasing cost pressure. With reasonable cost a banner year is certain.

State Road Programs

Illinois will enter the 1923 construction season with approximately 800 miles of pavement under contract. The state expects to let contracts for at least 200 miles of additional pavement, and plans are also under way to complete at least 1,000 miles of standard 18-ft. pavement during the season of 1923. Ample funds have been, or will be appropriated by the State Legislature now in session, to take care of this program; the funds coming from the $60,000,000 Bond Issue passed in 1918, also from current motor vehicle fee collections and Federal Aid financing.

New Mexico road program will be announced within the next six weeks. The Legislature having recently adjourned, a flood of bills for new work and appropriations are being signed by the Governor.

Finished Products React to High Raw Materials Prices

The National Industrial Conference Board in its weekly survey of industrial and trade conditions throughout the country issues the following:

Conditions in industry and trade are generally accepted as sound and business is active. A reflection of this improvement is evidenced by the fact that in some commodity lines the problem is not one of closing new contracts, but rather of meeting all demands and making prompt deliveries.

Prices of many raw materials, like steel, pig iron, copper, cotton and silk have been on the increase. Finished commodities are now beginning to react to these higher prices in the commodity market. Many steel mills report a shortage of common labor, which causes considerable concern in view of the spring exodus of those who favor outdoor employment. This gives weight to reports that a wage advance will be made in this industry before long.

Delay Federal Construction, Hoover Advises President

Industry Now Taxed to Full Capacity by Private Demands—Government Should Not Compete

In connection with the foregoing estimate of the situation, Secretary of Commerce Hoover's advice to the President to hold government construction in abeyance, at least for several months, on the ground that private work will tax the full capacity of the construction industry, is apropos. Mr. Hoover's letter, in part, is as follows:

"1. The year 1922 was a year of very large employment and activity in the construction trades and at the end of the year stocks of construction materials were very much reduced. Since the beginning of the present year there has been even more activity than in the same period last year and the contracts let in the past few months are of larger volume than any hitherto entered into in a similar period. Advance orders for construction materials are upon a very large scale.

"2. Labor in the construction trades and in the manufacture of material is not only at full employment but there is actually a shortage in many directions.

"3. Transportation facilities available for the building materials are fully loaded and almost constant car shortages are complained of with consequent interruption in production.

"My conclusion from all this is that, at least for the next several months, the trades will be fully occupied in private construction, all of which is generally needed by the country.

"For the Government to enter into competition at the present moment will give no additional employment to labor and no additional production of materials but must in the broad sense in the end displace that much private construction. The governments, nationally and locally, are in a much better position to hold construction work in abeyance than are private concerns, and are in better position to speed up in times of less demand as we did in the last depression as the result of the Unemployment Conference. We can by this means contribute something to a more even flow of employment not only directly in construction work but in the material trades.

"I would recommend, therefore, that you direct the different divisions of the Government to initiate no new work that is not eminently necessary to carry on the immediate functions of the Government and that there should be a slowing down of work in progress so much as comports with real economy in construction, until after there is a relaxation in private demands."

Recent Unit Bids On Large Contracts

Reservoir—Wellsville, Ohio

Bids were opened by Dept. Pub. Serv., Feb. 14, for constructing earthen reservoir. (A) A. W. Hinaman, Canton, Pa.; (B) Allison-Harris Co., West Liverpool; (C) Ambursen Constr. Co., Grand Central Terminal, New York City. The unit bids were as follows:

	A	B	C
Reservoir and dam complete of concrete construction (lump sum)	.....	.....	$134,800
26 acres clearing reservoir and dam site	50.00	80.00	100.00
12,965 cu.yd. earth excavation at dam site	.70	.90	2.00
161 cu.yd. rock excavation at dam site	2.00	2.00	6.00
60,000 cu.yd. earth excavation at Borrow Pit	.70	.70	.....
2 acres seeding embankment	25.00	260.00	.....
100 sq.yd. sodding embankment	.25	.33	.....
6,285 sq.yd. rip-rapping (dry)	2.00	2.75	.....
1,195 cu.yd. rip-rapping (grouted)	2.50	3.25	.....
100 cu.yd. clay puddle	1.00	3.00	.....
355 cu.yd. rubble masonry	15.00	10.00	.....
1,270 cu.yd. concrete (1-3-6)	20.00	17.00	22.00
10 cu.yd. concrete (1-2-4)	21.00	20.00	24.00
26,446 lb. steel reinforcement	.06	.05	.06
54 squares triangle mesh reinforcement	2.25	10.00	.....
1 gate house, complete, (lump sum)	5,980.00	6,635.00	.....
1 gate house operating equipment (lump sum)	100.00	.....	2,500.00
37 ton cast iron screens	.....	.....	.....
2.32 ton special c.i. lugged pipe	.....	.....	.....
22 ton 3-spans foot bridge	.....	.....	.....
1,000 cu.yd. road grading	1.00	.50	.75
500 cu.yd. crushed stone	4.00	2.50	6.00
Possible extras:			
Common labor, 200 hrs.	.50	.55	.65
Skilled labor, 100 hrs.	1.00	1.10	1.00
Team labor, 100 hrs.	1.00	1.00	1.25
Extended totals	$114,083	$117,214	$141,505

Filtration Plant—Baltimore, Md.

Bids were opened by Bd. Awards, March 7, for addition to Montibello filtration plant, (A) Carozza-Rowe Contg. Co., 624 North Gilmore St.; (B) Consolidated Eng. Co., Calvert Bldg.; (C) Sanford & Brooks, Commerce and Water Sts. The unit bids were as follows:

	A	B	C
Clearing and grubbing (lump sum)	$15,000.00	$1,450.00	$2,000.00
365,000 cu.yd. excavation	.65	.74	.90
74,000 cu.yd. rolled embankment	.15	.14	.295
270 cu.yd. class A concrete	50.00	46.30	41.50
30,800 cu.yd. class B concrete	18.30	19.50	20.10
14,600 cu.yd. class C concrete	12.05	11.50	1.160
3,760,000 lb. steel reinforcement	.05	.0525	.052
50,000 lb. expansion plates	.045	.15	.08
15,000 lb. miscellaneous steel work	.06	.18	.16
30,000 lb. iron castings	.06	.10	.13
5,800 ft. pipe railings	1.50	1.90	1.70
165 ton laying B&S pipe	25.00	18.00	54.50
110 ton laying B&S specials	25.00	20.50	63.00
350 ton laying flanged specials and valves	35.00	27.60	44.00
190 ton setting sluice gates	35.00	25.00	52.00
6 hatchways	150.00	165.00	200.00
4,000 duct. ft. fibre conduit	.10	.26	.26
600 ft. t.c. drains	.50	.55	.50
1,620 ft. sheet metal piping	.50	1.40	1.40
Crys. vat. foundations (lump sum)	2,000.00	1,000.00	800.00
Tar roofing (lump sum)	700.00	400.00	350.00
Extended totals	$1,248,955	$1,310,194	$1,414,816

Paving—Salina, Kan.

Following are lowest three bids opened by city, March 7, for paving, curbing and guttering various streets, (A) M. R. Ammerman, 248 North Market St., Wichita, (awarded contract for brick pavement, alternate No. 2); (B) Cook & Ransome, Ottawa; (C) Tibbets & Pleasant, Tulsa, Okla. The unit bids were as follows:

	A	B	C
24,000 cu.yd. excavation and grading	$0.70	$0.70	$0.75
5,000 cu.yd. concrete curbing alternate No. 1	.40	.75	.67
5,000 cu.yd. concrete curbing, alternate No. 2	.40	.65	.52
35,000 cu.yd. combined curb and gutter, alternate No. 1	.80	.90	.92
35,000 cu.yd. combined curb and gutter, alternate No. 2	.80	.80	.77
80,000 cu.yd. brick paving, alternate No. 1	.....	3.29	3.28
80,000 cu.yd. brick paving, alternate No. 2	3.18	3.19	3.22
80,000 cu.yd. asphaltic concrete pavement, alternate No. 1	.....	.....	2.98
80,000 cu.yd. asphaltic concrete pavement, alternate No. 2	2.30	.....	3.90
80,000 cu.yd. reinforced concrete pavement, alternate No. 1	2.28	2.60	....
Concrete header at end of pavement	.40	.50	....
Cubic yards extra concrete	10.00	20.00	....
Sq.ft. new concrete walks 4-in.	15.00	.18	....
Sq.ft. concrete walk taken up and relaid	.14	.10	....
Sq.ft. brick walk taken up and relaid	.10	.10	....
Sq.yd. old brick pavement relaid with asphalt filler	.10	.10	....
Cu.yd. extra broken stone or gravel	3.25	5.00	....
Cu.yd. extra sand	3.00	2.25	....
Extended totals brick, paving	$301,200	$303,250	$305,150
Extended totals asphaltic concrete paving	$231,200	.....	$279,550
Extended totals reinforced concrete paving	$229,200	$256,050	.....

All totals on Alternate No. 2.

Last Week's Contracts About the Same as Year Ago

Last week's Construction News section was the heaviest on record. Its nineteen pages carried 856 tips to construction men. The principal increase was in proposed work which had not yet reached the contract-awarded stage.

The value of contracts for the week of March 15 was $37,226,000, against $38,000,000 for the same week last year and $23,000,000 for the corresponding period in 1921. The average weekly value for March, 1920, was $37,000,000 the same as last week.

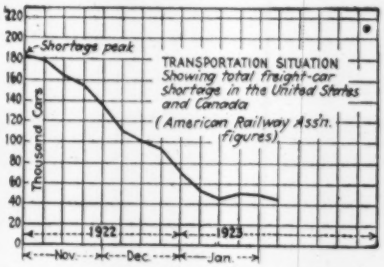
Of the $37,226,000 awarded during the week, $17,138,000 was for public improvements and $20,088,000 for private projects. Building awards, above a minimum value of $150,000 and amounting to $12,217,000 for the week, were divided as follows: $10,237,000 for private and $1,980,000 for public buildings. Canadian lettings reached a total value of $4,630,000 as against $4,805,000 for the Southern and $4,823,000 for the Western sections of the United States.

Gain in Car Loadings Due to Coal and Merchandise

All Seasonal Records Broken—Heaviest Since Dec. 9—Increase in Demand —Fewer Bad Order Cars

With freight loadings totaling 917,896 cars for the week ending March 3, freight traffic continues to break all previous records for this season of the year, according to the American Railway Association.

The total for the week was an increase of 124,781 cars over the corresponding week last year, and 206,529 cars in excess of the corresponding period in 1921. It also exceeds by a considerable margin the same weeks in 1918, 1919 and 1920.



CAR SHORTAGE SINCE PEAK

The increase of 87,673 cars over the week ending Feb. 24 was largely due to heavier shipments of coal and merchandise and miscellaneous freight, which includes manufactured products.

Loadings for the week of March 3 were the heaviest of any week since Dec. 9, 1922, and indicate a stimulation in business unprecedented for this time of the year.

NUMBER OF CARS LOADED WITH REVENUE FREIGHT

Week Ended	1923	1922	1921
Mar. 3	917,896	793,115	711,367
Feb. 24	830,223	728,925	659,642
Feb. 17	817,778	773,275	692,007
Feb. 10	853,289	777,791	687,867
Feb. 3	365,675	747,895	699,718
Jan. 27	871,164	740,386	701,605
Jan. 20	865,578	731,109	708,658

Demand for freight cars in excess of the current supply amounted to 80,633 cars, Feb. 28, an increase of 3,783 since Feb. 23.

Fewer freight cars were in need of repairs on Feb. 15 than at any time during the last two years. On that date, 206,585 or 9.1 per cent of cars on all lines were in bad order. This represents a decrease since Feb. 1 of 2,886.

Locomotives in need of repairs, Feb. 15, totaled 15,581, an increase, due to bad weather conditions, of 169 over the total of Feb. 1. This represented 24.1 per cent of locomotives on all lines.

New freight cars of all descriptions on order Feb. 15, totaled 97,932, an increase of 29,600 over the number on order Jan. 1, 1923.

Structural Steel Sales Increase

A further increase in sales of fabricated structural steel is reported for February by the Department of Commerce through the Bureau of the Census. Sales amounted to 80 per cent of shop capacity as against 76 per cent for January. Total sales reported for February by 151 firms, with a shop capacity of 219,955 tons per month, amounted to 176,787 tons, the highest since last May.

Tonnage booked each month by 164 identical firms, with a capacity of 223,355 tons per month, is shown in the accompanying table, pro-rated to a capacity of 250,000 tons per month, together with the per cent of shop capacity represented by these bookings.

FABRICATED STRUCTURAL STEEL SALES

1922	Actual Tonnage Booked	Per Cent of Capacity	Estimated Total Booking
April	197,796	89	222,500
May	181,503	81	202,500
June	162,876	73	182,500
July	153,903	69	172,500
August	152,253	68	170,000
September	143,566	64	160,000
October	128,315	58	145,000
November	108,593	49	122,500
December	130,082	58	145,000
1923			
January	168,336*	76	190,000
February	176,787**	80	200,000

*Reported by 161 firms with a capacity of 222,605 tons. **Reported by 151 firms with a capacity of 219,955 tons.

Building tips in Construction News last week totaled 270, and 55 were for buildings to cost $500,000 and over. These latter aggregated $50,000,000, in the following stages: 38 proposed building jobs, to cost $38,000,000; 9 bids-desired, $6,150,000; 2 bids-received, over $2,000,000; 6 contracts awarded, $4,000,000.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of March 1; the next, on April 5.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.44	$3.95	$4.50	$3.20	$3.45	$3.95	$3.45	+$4.00	$3.75
Structural rivets, 100 lb.	4.00	4.60	5.25	3.75	4.00	5.15	4.75	+4.50	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.34	3.85	3.15	3.10	3.35	+3.97½	3.30	+4.00	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	51%	53%	45%	59½%	55-5%	38%	38.2@46.5%	45%	32.76
Cast-iron pipe, 6 in. and over, ton.	+57.20	52.50	57.00	+55.20	60.50	65.00	57.00	58.00	55.00
Concreting Material:									
Cement without bags, bbl.	2.70@2.80	2.90	2.25	2.20	2.39	2.85	2.71	2.90	2.88
Gravel, ¾ in., cu.yd.	2.00	1.75	2.25	2.25	1.75	1.90	2.15	1.00	1.50
Sand, cu.yd.	1.00	1.24	1.87½	2.25	1.00	1.00	1.50	1.00	1.25
Crushed stone, ¾ in., cu.yd.	1.75	2.00	2.50	2.25	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	63.00	38.00	53.00	60.50	44.75	51.00	39.00	+30.00	95.00
Lime, finishing, hydrated, ton.	16.80@17.10	23.00	22.50	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.95	2.50	1.50	1.25	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	23.50	13.00	+11.60	11.00	17@19	12.00	15.50	13.00	16.50
Hollow building tile, 4x12x12, per block	Not used	.0859	.115	....	.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	.1314	.0859	.115	.0674	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal.	+1.04	—1.05	1.16	1.12	+1.16	1.25	1.09	.86	1.17
Common Labor:									
Common labor, union, hour	.60	.35	.30@.50	.....	.....	.50@.55	.56¼	....	.....
Common labor, non-union, hour.	.45@.60	.30	.30@.50	.72½	.35@.50	.35@.50	.50	.30@.70	.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81½c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine casing. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.77). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $32.76; 6-in., $108.

Changes Since Last Week

Consequent to recent advances in coke, iron and steel scrap and pig-iron prices, structural shapes are now quoted at a minimum of $2.35 per 100 lb., Pittsburgh mill, with $2.50 applying on specified deliveries. Plates are also at a minimum of $2.35, with offers of $2.50@$2.60 to secure deliveries in thirty to sixty days. Bar mills are completely sold up for the next quarter. A minimum of $2.35, however, is quoted on large tonnages, with small lots for quick shipment not under $2.50 per 100 lb.

Reinforcing bars quoted in Denver warehouses at $3.97½ as against $3.62½ per 100 lb.; in Seattle, $4, advanced from $3.80. Seattle also reports advances of 20c. on steel shapes and 25c. per 100 lb. on structural rivets.

Bessemer pig iron up 23c., basic, 50c. and No. 2 foundry, $1.50 per ton at Pittsburgh. Following pig-iron rise, cast-iron pipe, 6-in., advanced to $57.20, from $56.50 per ton, in New York; Chicago quotes $55.20, compared with $54.20 per ton, one week ago.

Lime, brick and concreting materials, generally, show marked price stability in the current market. Brick, however, advanced 60c. per M in Dallas.

Lumber mills, particularly yellow pine, are sold up for some weeks ahead; price levels remaining fairly firm. Seattle, however, reports a rise in Douglas fir, to $30, as compared with $29 per M ft. b.m., last week. The inadequate car supply in the Southeastern lumber districts is reported to be growing in seriousness.

Raw linseed oil, in 5 bbl. lots, advanced to $1.04, f.o.b. New York, as against $1.02; in Minneapolis, $1.16, compared with $1.13 per gal. Atlanta reports a decrease to $1.05, from $1.07 per gal., one week ago.